Vol. 1-9

PAVING AND MUNICIPAL ENGINEERING.

A Journal Devoted Specially to Street and Sidewalk Paving, Water Works Construction, Bridge Building, Street Lighting, Sewerage and all Matters Pertaining to Public Improvement in Cities.

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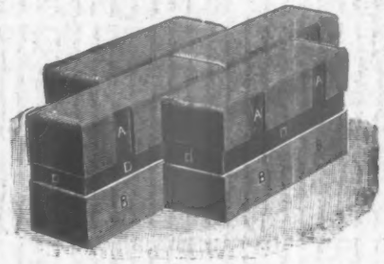

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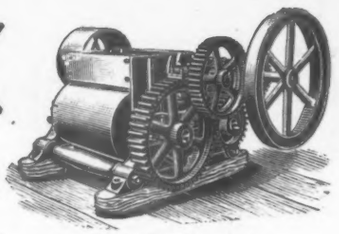

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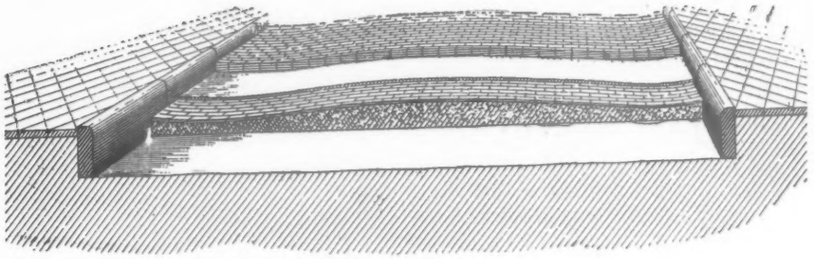

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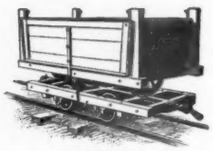
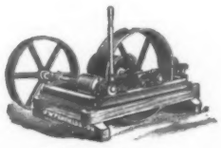


(Clay Car.)



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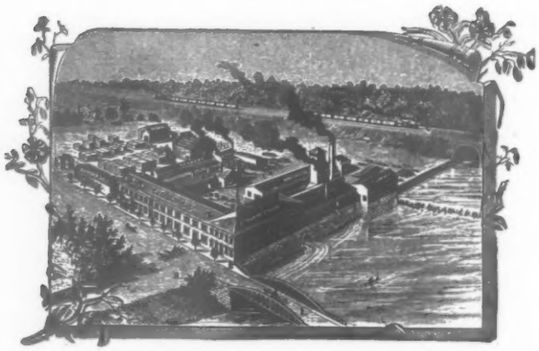

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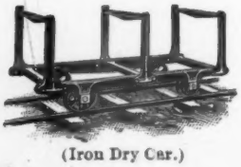

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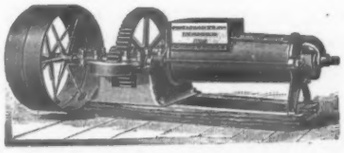

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THE CARE OF STREETS IN EUROPEAN CITIES.

By Louis H. Gibson.

SINCE leaving Glasgow I have been in Belfast, Edinburgh, Leith, Liverpool, London, and am now in Paris. In each of the cities I have pursued my investigations with respect to the building of streets, and incidental thereto I think I have come to a matter which is quite as important as the construction of streets or roadways, viz., their care after they are built. The Americans are on the wrong track, as I understand it, in street work. They are searching for the perfect roadway, the cheap and indestructible; a street which when built will not require farther attention for a long term of years. This is the American ideal, and it is what many are struggling for. With us many streets are constructed with the idea that for a long time they will not require attention, and if repairs are needed a great hullaballoo is created, and a demand is made for a new kind of street. Thus it is that the material which we were using a few years ago we are not using now. Constant changes are being made, and nothing appears to be satisfactory.

The public impression is that the best streets are to be seen in Paris. It is my impression that they are to be found in Glasgow. But be that as it may, take Paris as an example. Men are working on the streets all the time. There are wooden block pavements, stone block pavements, asphalt, and what not. They are subject to constant inspection. I was told by a gentleman who had watched one of the wooden pavements which crosses the Champs Elysees and is subjected to very heavy travel, that it has been down for eight years, and is yet in good condition. It may be asked: How was the street put down? What kind of a foundation has it? How were the blocks treated? What is their size? Of what material? But while this is important, these are questions that need not be answered here. The real secret of the present condition of this street, after years of the most extraordinary wear, is the attention which it has received since it was put down. Primarily it has been kept clean. Then it has been subject to constant inspection. If a soft block or a bad one made its appearance it was immediately taken out and a new one put in and trimmed down to the proper level. This is going on all the time. Any little imperfection which showed was immediately corrected. If it was in the foundation it was cut out and renewed.

The authorities here go on the principle that a stitch in time saves nine; hence, good streets—streets maintained at relatively a slight expense. In the case of a block pavement, where a single block fails if it is neglected, the adjacent blocks are hammered out of shape by the wheels of the vehicles. The low place in the pavement causes the wheel to strike on the sides of the next adjacent block, and thus knocks it out of shape. Like a rotten place in an apple, it soon spreads. The same is true of a composition pavement—asphalt, cement, or anything of that kind. All these pavements receive in Paris just the attention I have mentioned.

I mention this matter as to Paris because it comes to me in connection with a street which has had eight years of most extraordinary wear under travel quite as heavy as any street of which I have knowledge in America. But in all of the cities which I have mentioned I have seen men at work renewing sections of asphalt, putting in new blocks of wood or stone, as the case may be, and altogether giving them the most careful attention. A gentleman in Glasgow told me that the failure of a single block of stone would cause a large number adjacent to it to be destroyed within a few days if not properly cared for.

I have had a chance to see the streets of London and those of Paris under about the same conditions, frosty and sloppy weather. In Paris the streets were sprinkled with sand as soon as the frosty weather appeared. This prevents the horses from slipping. In London, under the same conditions, one could see them sliding all over the streets, and altogether suffering dreadfully. In the same city, when it began to thaw and rain, the streets were slippery from that cause, and allowed to remain so. In Paris, as soon as the temperature goes above freezing, the sand is washed off and the streets scraped and slushed in a way to leave them in a good condition for travel. All solid streets are very slippery under a light snow, heavy frost, or a general sloppy condition. A wooden block pavement is quite as bad as any under such conditions: asphalt is very treacherous, and stone not quite so bad. As soon as the thaw comes on the asphalt in Paris, the care-takers come out with long "squeegees," the same as those used in cleaning plate glass in our American cities, excepting that they are larger. They are a board about two and a half feet long, with the strip of rubber set in the bottom edge. By pushing these over the street the water is kept in front and the pavement thus made quite dry after a thaw or a rain. By holding them at a slight angle of inclination to the sidewalk, all the water and slush is pushed into the gutter and from thence into the sewer. This "squeegee" for the asphalt pavements is, I understand, a Paris institution, and helps to keep them dry and in good condition.

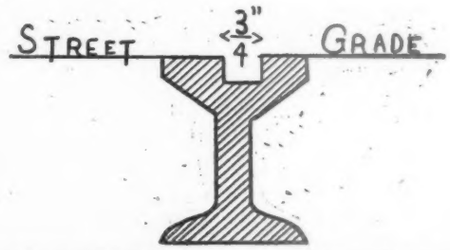
I trust that I have indicated fully enough that in the older European cities it is not expected that a pavement of any kind will take care of itself and remain in good condition. Before we can expect to have good streets in America we must appreciate

the necessity for constant attention. Of course we will have to make them better than many of our streets have been made, but even then we can not expect good results excepting at the price of eternal vigilance. This can not be too strongly emphasized.

They have been experimenting with a new foundation for wooden pavement in London. They put down a six inch concrete base on the rolled earth, on top of which concrete is placed a layer of two inch planking. Next from an inch and a half to two inches of sand, and on the sand a block pavement of wood. All of the woodwork is dipped in creosote with the idea of adding to its lasting qualities. Otherwise it is treated in the ordinary way. The wooden pavement with the concrete base is common enough, though it is usually somewhat heavier than here indicated. It has been found that such a pavement becomes quite noisy in time, and has very little spring to it. The wooden planks and the sand are used for the purpose of making what is called a softer pavement. One somewhat more springy, less noisy and altogether more comfortable to drive on. There are several such streets in London.

It is interesting to notice that wooden block pavements are being revived in many foreign cities. I may state that this is true in New York as well. It has come to be acknowledged that a street must be cared for under any circumstances and that where there is a good foundation, proper attention will keep any well known material in fair order.

In speaking of asphalt pavements we always hear Paris referred to as being a city in which they are largely used. This is true, though wood and stone pavements are quite common—stone very generally where the travel is heavy. I will say that the character of the surface of the asphalt pavements is quite different from what I have been used to seeing in American cities. While it is smooth as to the general surface it appears to be made from coarser material, and while the surface is dark there are indications that a great deal of very fine gravel is used in the surface composition, for which reason it is easier to travel over during the period when such pavements are usually very slippery. But as said before they are subjected to special care with respect to this condition.

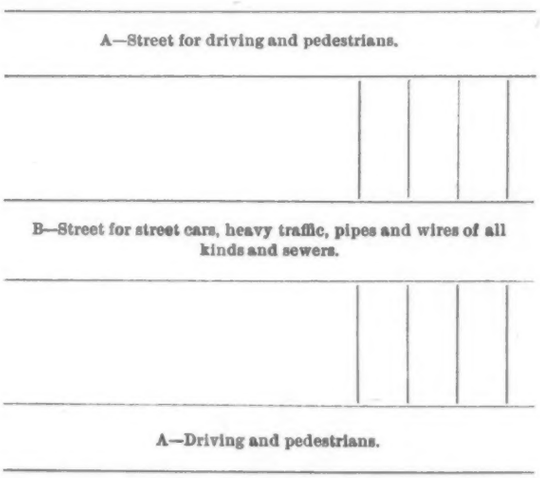


Street railway rails which do not interfere seriously with the travel of ordinary vehicles are certainly an improvement upon what we have in most of our American cities. I find in all of the foreign cities which I have yet visited, a most excellent form of rail which does not obstruct or make disagreeable in any way general street travel, and for which reason a street that has the tracks running through it is little, if any, more to be shunned by vehicles than others through which the cars do not pass. The form as shown on the surface is as per sketch herewith submitted. While I am not pretending to give a drawing from which a rail could be rolled, it indicates clearly enough the design. Instead of having a flange on the outer edge the rail has the small channel in the center, and as this channel is not more than three-quarters of an inch wide in some cities, though a little wider in Paris, the wheels of an ordinary vehicle do not run into it. As far as I know none of the foreign carriages have their tires narrow enough to be in any way affected by running along or over a street railway track. Thus it is that having the iron set flush with the pavement and with the narrow channel in the center of the rail we have a track which in no way disturbs general traffic. Even in our American cities where there are the light buggies with tires that would find their way even into a three-quarter inch groove, it would be found that in a short time these narrow tires would disappear if this form of rail were gradually and generally adopted. With us it is usually considered a great calamity to have a street railway line go through a street, but I can assure any one that, with this form of rail, it is not in any way disagreeable excepting in the mere passing of the cars.

REFORM IN PLANNING STREETS OF CITIES.

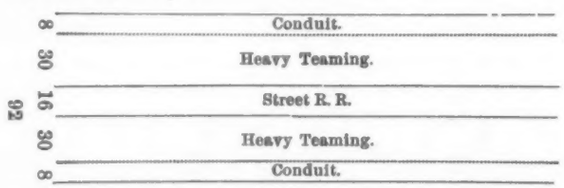
By F. F. Merriman, C. E.

IT has become evident to every careful observer that a reformation is necessary in the ordinary way of planning and laying out streets of cities. With all our modern necessities, such as water, gas and electric light supplies—street railroads, sewers, telegraph and telephone wires, etc., our streets have become too much congested. Then the necessity of tearing up these streets for the purpose of connections, is a constant source of expense, danger and annoyance which should be avoided in the future. In seeking a solution of this difficulty, a plan has occurred to the writer, which he offers as a suggestion or ground of discussion. It is this, that whereas streets are now laid out, say, 300 feet apart, with an alley midway between, that in the plan of the alley a good, wide street be drawn on the plan.


A—Street for driving and pedestrians.
B—Street for street cars, heavy traffic, pipes and wires of all kinds and sewers.
A—Driving and pedestrians.

The streets A A would be the principal streets, on which the buildings would front, would have good, wide flag walks, and be paved with one of the lighter kinds of pavement, such as brick or asphalt, or McAdam.

They would carry no water or gas pipes, no wires or sewers or street railroad, and would not be intended for heavy traffic, sixty or seventy feet would probably be sufficient for the width of these streets. The lots might be planned from 100 to 140 feet in depth and the streets B. B. from 80 to a 100 feet in width. All streets to be kept clean and in good sanitary condition.



In the center of this street B. 16 feet might be reserved for use of street car tracks. On either side a width of 30 feet might be paved with granite blocks for heavy traffic, and on either side and along the rear of the lots a width of eight feet might be set off for conduits, these to hold all pipes and wires and to be covered with a heavy thick flagging on the same surface line as the granite paving allowing teams to drive close up to the buildings on the rear of the lots. The surface water could be conducted for the most part along the curbing of the main and transverse streets. All connections of pipes and wires with buildings would be from the rear instead of from the front. The street cars would stop only at the crossings of the transverse streets which would be laid out 600 or 800 feet apart and would also be free from wires and pipes, although not entirely free from heavy traffic and street railroads.

PUBLIC MORALS AND ROAD-MAKING.

By W. L. S. Bayley, C. E.

MARSHALED by "THE PAVING AND MUNICIPAL ENGINEERING," Messrs. Sherman, on Liverpool, Howard, on Paving, Maxwell, on Sewage, and Gibson, on Glasgow, have shown conclusively that it is in the moral phase of the question, as to how public works shall be prosecuted, that the secret of permanent and substantial public improvements lies. It is probably not true that our people as a whole occupy a lower rung upon the ladder of integrity and public morals than do those of the cities on the British Islands; and yet it can not be successfully denied that the license which our form of government gives is largely responsible for the municipal corruption which seems to everywhere prevail throughout the length and breadth of this land. Perhaps it is safe to say that, while the official management of the European cities is controlled by a strict sense of official justice (leaving the morals of their people, as a whole, out of the question), the situation is completely reversed in our land.

Our best foot is not put forward. Our municipal control is not even second rate, but the cities seem to be and are under the ban in that they must provide the sinews of war for the political party in power. Granted that the sleight of hand of the English mason, in the construction of the sewers of Liverpool, is identical with the same cunning which fills the interstices of the Chicago sewers with a red sand which so closely resembles the so-called native cements that, with the inspector's back turned, this sleight is successfully covered up before he again scrutinizes the work of the cute expert, the question reverts to "What are you going to do about it?" We answer that we will insist, in season and out of season, that the control of city improvements shall be in the hands of civil engineers, with sufficient brain and brawn to propose and perfect legitimate construction throughout their bailiwick; but extreme caution is advised that education is only one member of the triumvirate essential for a successful prosecution of their responsible duties.

With only the mention of the trio, we leave this important question, hoping that it will be taken up by abler pens, who will sustain the claim that *Ability*, *Morals* and *Finance* are inseparable.

THE SETTING OF CEMENTS.

[Translation by Alden H. Brown of part of an article by Prof. Engle, in *Ladenburg's Handwoerterbuch der Chemie* and published in *The Transit.*]

BY the setting of a cement we mean the change of the cement from the pulverulent to the solid form, either when mixed with water alone, or with water and other substances. The quantity of water used should be regulated according to the kind of cement, since every cement has a certain given capacity for water of course, however, in practice a quantity that is somewhat greater this must generally be used.

The amount of water absorbed from the air by Portland cements (1) and hydraulic limes (2, 3, 4), varies considerably with the time, as will be seen by the following table by Feichtinger:

	1	2	3	4
	Per cent.	Per cent.	Per cent.	Per cent.
Fresh ground.....	.99	1.28	.61	6.79
After 4 hours.....	1.41	1.67	.71	7.80
" 20 "	2.29	2.08	1.14	8.26
" 3 days.....	5.62	3.42	1.82	8.07
" 7 "	6.58	3.85	2.15	11.20
" 14 "	7.96	4.46	2.63	11.80
" 28 "	10.52	8.30	6.20	14.48
" 80 "	11.56	9.50	7.40	14.65

In practice about 50 per cent. of water is generally used, which is a great excess, so that there is usually about 30 per cent. of water to be driven off by evaporation.

The more vitreous the character of the cement, and the harder and sharper its grains, the longer is its time of setting. Cements which require more than one-half hour to set are called slow setting, all others quick setting. It is also a well known fact a cement does not attain its maximum hardness until some time has elapsed, often not until many months have passed. For good Portland cement fifteen days usually suffices for complete setting, *i. e.*, not complete hardening. The rapidity of the setting depends to a great extent on the temperature, and also, but in less degree, on the purity of the water.

It has been known for some time that sea water hinders the setting of most quick setting cements, and that some cements which are very hard in fresh water, only harden slightly in sea water or even remain soft. Vicat attributes this principally to the action of the magnesium sulphate of the sea water on the lime, converting it into calcium sulphate, yet Feichtinger's experiments would make it appear that, beside the magnesium salts, the chlorides of calcium, sodium and potassium, take part in this process. Rivot and Chatoney attribute this action to the carbonic and sulphuric acids present in the sea water, and also to the magnesium salts contained in it. To avoid this action Kuhlmann recommends adding sodium silicate (water glass) to the mortar. Michaelis advises a double or triple coat of this material.

The rise in temperature is much more apparent in the setting of quick setting cements than in others, because the external cooling is relatively much less.

Herzog obtained the following results concerning the rise in temperature of a Portland cement, which he formed while wet into a prism 10 centimeters long and at another time into a prism 20 centimers long. In each case the original temperature was 13.5°c:

10 Centimeters Long.		20 Centimeters Long.	
Immediately after molding..	16°	Immediately after molding....	19°
After 30 minutes..	17°	After 1 hour and 30 minutes..	20.5°
After 70 "	17.5°	After 2 " " 30 " ..	22°
" 4 hours	18°	" 4 " " 30 " ..	24°
" 5 "	18.5°	" 5 " " 30 " ..	38°
" 6 "	23.5°	" 7 "	43°
" 7 " and 30 minutes..	27°	" 8 "	45°
" 8 " max.....	29.5°	" 8 hrs. 30 min.max.....	45.5°

Thus we see that the temperature increased 16° in one case and 32° in the other, accordingly the rise in temperature was proportional to the side of the cement prism. Thus it will be seen that all theories about the rise in temperature of setting cements, have no value unless they take the volume of the cement into account.

The volume of the cement should remain constant through the whole setting process. It is especially important that the cement should not increase in volume, or swell as it is called. This is due to the presence of free calcium oxide which on taking up water expands, forming the hydrate. According to Michaelis a properly composed cement should exert so great a resistance to the expanding calcium hydrate, by the hydratization of its constituents and the intimate mechanical intermingling of the resulting hydrates that no swelling can take place. He says in support of this that good cement mortars do not swell when lime has been added to them.

The swelling of a cement may be shown by allowing the plaster to harden in a glass vessel, which will be broken by any change in volume, but sometimes the rise in temperature will effect this result. More certain results may be obtained by spreading the cement paste on glass plates and allowing it to harden; any change in volume will be shown by the cracking of the material.

According to Erdmenger the cements made from dolomitic lime-stones show a great deal of swelling.

One of the most important qualities of cement is its compressive strength; since the direct determination of this is a matter of considerable difficulty, the tensile strength is the standard most generally adopted in determining the strength of a cement.

Good cements should have a tensile strength after setting under water four weeks, of not less than 10 kilograms per sq. c. m.; most good cements will give considerably better results, from 15 to 25 kilograms and more.

In the case of Portland cements, according to most authorities, the relation between tensile and compressive strength is reasonably uniform, yet this is not the case when weak hydraulic limes are to be considered, and no reliable conclusions regarding their

compressive strength can be obtained from tensile tests. In this case the compressive strength must be obtained by direct determination. Such tests are usually made with prisms of cement, and a good cement should have a compressive strength about ten times as great as its tensile strength. Dyckerhoff says that the form of these test specimens affects the results, and that if they are made in the form of discs, the results obtained are much higher.

The hardened cement should be but slightly dissolved by water. According to Feichtinger, 15 grains each of Portland cement and Bavarian hydraulic lime dissolved as follows in sixty litres of water:

	Portland Cement.	Hydraulic Lime.
Calcium.....	1.408	.868
Alumina.....	0.032	.020
Silica.....	0.102	.137

Cement masonry under water is protected from most destructive agencies by the water itself. For the carbolic acid of the water combines with the lime of the cement, forming a protecting layer of calcium carbonate, so that cements that have been long under water contain 15 to 18 per cent of calcium carbonate.

The hardening process which takes place when a cement is mixed with water has been explained in many ways, and as yet no theory has been advanced that fulfills all the conditions of the problem. Most authorities, however, ascribe the action to the formation of calcium silicates and aluminates, or else double silicates of calcium and aluminum which contain water of crystallization. Opinions differ, however, as to the manner in which these substances are formed, some claiming that they are formed in the process of burning, and exist in the anhydrous condition in the dry cement, and that they immediately crystallize out on the application of water. Others hold than at any rate the formation of these substances is only partially completed by the burning process, and that they are formed while the cement is setting by the action of calcium hydrate on the burned silicates. Feichtinger says that the incipient setting of a cement takes place in the manner first described, while the slower hardening process is due to the action of the calcium hydrate on the silicates.

Schott found that mixtures of calcium, silica, alumina and iron in the following proportions produced very good cements when properly burned and ground:

	1	2	3	4
Silica.....	24.8	23.8	23.3	24.3
Alumina	11.4	.....	6.5	6.9
Ferric Oxide....		11.4	4.7	4.8
Calcium carbonate	64.8	64.8	65.4	64.1

From this he assumes that the hardening of a cement is not due to any certain chemical process, and Knapp, who also inclines to this opinion claims that it is due to the mutual action of chemical and mechanical processes.

WATER AND SEWERAGE WORK FROM A SANITARY STAND-POINT.*

By John W. Hill, C. E.

ONE of the earliest writers upon hygiene and sanitation was Hippocrates, who first pointed out (with some errors, it is true) the prime causes of ill-health, and who sought by precept and example, to remedy many of the principal evils due to ignorance or neglect of the simplest sanitary precautions. He it was who claimed that no one could be in a state of good health excepting he was supplied with pure air and pure water, and resided over a pure soil; and accepting the modern theory of the propagation of disease by means of bacteria or germs, we can readly understand how what Hippocrates meant as impure air or impure water could convey to a susceptible system the seeds of a dangerous complaint.

The facility with which certain so-called contagious diseases can be transmitted from the sick to the well, is well known to the physician, who, in cases of scarlet fever, diphtheria, small-pox and some other forms of human complaint, requires all clothing or bedding used by the patient to be destroyed by fire; and that the premises where such diseases have had existence shall be thoroughly fumigated or disinfected, directly the patient recovers or dies. All of which is done to destroy the germs of diseases which he knows to be actually present in such clothing and in the permeable fabrics of the room and house. Air may be rendered impure by the noxious exhalations of decaying animal or vegetable matter; and diseases of a malarial and enteric nature are frequently traced to an exact source. Indeed malaria means a complaint due to bad air, but all diseases traceable to bad air are not malarial in their course and attributes. All diseases which have their origin in the respiration of an atmosphere charged with sewer gas, or with the deadly gases or suspended matter from certain manufacturing operations, as for instance, the manufacture of white-lead, may be said to be due to impure air, by means of which the germs or causes of diseases are introduced into the system, an abnormal condition is established, and the patient yields to sickness.

From impure water we derive several forms of enteric disease, chief of which we know to be typhoid and sometimes typhus fever, dysentery, diarrhoea, possibly rheumatism, and I have seen it stated upon high authority that the deadly disease known as cancer can in some cases be traced to the use of impure water.

The greatest danger lurking in impure water is typhoid fever.

From an impure soil, come the exhalations which vitiate the atmosphere, through which the germs of disease are readily introduced into the system. A uniformly damp soil is, in my judgment, quite as dangerous to human health, as a polluted soil; continuous residence over a damp retentive soil is bound to develop trouble in the organs of respiration taking the form of phthisis.

A pervious soil, or one through which the water will freely pass, should always be chosen for a permanent habitation, especially for growing children. There is a popular notion that a residence on high ground is better than a residence in a valley, from the belief that all surface and subsoil drainage passes freely from the former and is always present in the latter; this is not always true, neither is it generally true, for the high land, excepting it be rock, indicates a tough and generally retentive clay not easily eroded by water, else it would not be high land.

When the glaciers ploughed over the country, the probabilities are that the substratum was generally uniform in altitude above any given datum plane, but the abrading action of the ice and the stones carried in the grasp of the ice, cut away the softer and more yielding soils forming the valleys, and left the harder and tougher soils standing as the high lands.

Sometimes the clay soils cut from the higher grounds are found in the valleys, but often the valley is found to contain the more pervious soil, in which case it will be better to choose the valley than the high ground for a place of habitation.

One cause of the popular belief that a residence on high land will be more healthful than one on low land, may be due to the fact that the habitations from force of circumstances are more closely built together on the low ground, and that on a given acreage a much larger population is contributing to the sanitary injury of the soil by the fæcal deposits and the refuse from the household.

The constant pollution of permeable ground surrounding privy vaults and cesspools, will result eventually in unfitting the soil for human habitation, and to remedy the evil every organized community should provide for the prompt and efficient removal from the premises of all excrementitious matter and wastes of every description. Garbage should not be thrown in sewers to strand and decompose, but should be removed from the premises to a point far enough away to avoid pollution of the atmosphere by the decaying matter.

When it becomes, as in some of our larger cities, inconvenient to carry garbage to a distant point of deposit, then provision should be made to burn it as rapidly as it accumulates; fire being the best and only certain agent for the destruction of organic matter in animal or vegetable wastes.

* Read before the Board of Trade of Marietta and Hanover, O., and subsequently by request read to the Cincinnati Club of Civil Engineers.

The fact being established, over and over again, that the prime causes of ill health, especially that which may partake of an epidemic character, are to be found in the bad sanitary arrangements of the community, or of the household, it becomes the duty of every citizen, in his own behalf and in behalf of his neighbor, to see that his premises are in good sanitary condition; and as a factor in the community it is his duty to insist upon such general and public improvements in water supply, sewerage and garbage disposal as will at all times insure the absolute freedom of the corporation from the danger arising from bad air, unwholesome water, and damp or polluted soil.

It is not possible to regulate personal cleanliness or individual habits by any general sanitary improvements, but the cleanliness and habits of a community, taken as a unit, can be materially promoted by recourse to the proper methods for rendering pure or wholesome the air, the water, and the soil.

The experience of English engineers who have studied the sanitary problem, is convincing testimony upon the certain benefits to public health of well-constructed sanitary works; and Mr. Baldwin Latham has even gone so far as to attempt to prove, by example, that the money value of all the necessary public improvements for maintaining or advancing the health of a community is more than recovered by the reduced expenditure for doctors' and undertakers' bills; by the loss of time in the usual occupations of life of those who are sick or detained from work by the sickness of others; and by the increased strength and longevity of those whose labor is necessary to their own support or to the support of others.

As is well known the method in China of feeing physicians is very different from ours; there the doctor is engaged by the year at an annual salary, which stops during the time any member of the family by which he is employed is ill, from which as a consequence it is very important for the physician's pecuniary interests that his patients be kept always in a state of good health. By the same token it seems to me more desirable that we expend our money in sanitary works for the preservation of health, rather than in large outlays to recover that which by proper sanitary precautions should not have been lost.

The general sanitary arrangements which a community can construct to improve the public health, are embraced under the heads of "Water Works," "Sewerage," "Surface and Subsoil drainage," and "Garbage Disposal."

No works of a public character can insure absolute cleanliness of every household, for this as we all well know depends upon individual habits. Some persons shun dirt of every kind as they would a dangerous enemy, while others seem to court it as a friend.

The advantage to health of a public water-works over the usual private wells or cisterns are found in the improved character of the water, and the uniformity of the supply in all seasons.

Starting upon the assumption that the source of a public water supply is known to be wholesome or free from marked pollution, the use of water from the mains uniform in its quality, will guarantee a better condition of public health than cistern or well water, from the fact that the latter in many instances are open to contamination from the domestic cesspool and privy vault, the contents of which are usually permitted to permeate the surrounding soil and often filter into the sources of domestic water supply.

Moreover when water for all domestic uses is drawn by manual labor from wells and cisterns, no more is used than just enough to supply the simplest necessities of the household, while with water drawn from the city mains no limit is placed on the quantity drawn; and while much may be wasted, no one is likely to complain of unsatisfied wants.

For the kitchen, the laundry, the bath, the water closet, the urinal and the lavatory, such quantities are usually taken from the public pipes that if drawn from private sources of water supply, would involve an amount of labor which no ordinary householder could afford to support for any reasonable length of time.

Indeed without public water-works many of the recognized adjuncts of sanitation can not be had in any but the more costly and elaborate residences; while with public water-works no one need be deprived of at least the simpler and less expensive sanitary appliances.

For a family of eight persons, if the water for all domestic purposes is drawn from the city mains, consumption will average through the year about forty gallons per capita, or three hundred and twenty gallons per day for the household. A cistern of moderate capacity will contain,—say one hundred and fifty barrels, or five thousand gallons; now at the rate of three hundred and twenty gallons per diem such a cistern would furnish water for the family for a period of less than sixteen days, and yet we know from experience that this volume of water will support the household, in the absence of any other course of supply, for upwards of three months.

The difference in rate of consumption between cisterns and public pipes, is partly due to the known limit of the first source of supply, but much more is it due to the labor required to draw it; which in the case of the cistern, is such that no one indulges in the work for a past time, while with water from the pipes no labor at all is necessary to obtain the largest quantities desired.

The advantage to an organized community of a wholesome and copious supply of water was well known to the Romans, who provided in many of the cities they built such liberal quantities of water for public uses as to put to shame some of our modern efforts in this direction. Of the fourteen aqueducts supplying the city of Rome in the time of Nero, three (3) are in a state of good preservation, and are to-day furnishing the water supply of modern Rome.

Of these the "Anio Novus" Aqueduct brought water from a source sixty-two Roman (or fifty-eight and seventy-one one hundredth English) miles distant from the city. In remarking upon these works Mr. J. F. Batemen says, "If to obtain a proper incline the water-course had to be carried above ground, the simplest plan was to support it on a stone wall, and in this case the conduit itself was also built of blocks of stone, coated with stucco impervious to water. But since a solid wall across a valley would have cut off the usual traffic, it was found necessary to break up the wall by means of pillars (or piers), and with this commenced the system of aqueduct bridges, which have proved to be the most striking monuments of the Roman Empire." In some instances these stone aqueducts were made to perform a double office, that of carrying water in the upper part, while the lower part or archway was used as a city gate; a familiar illustration is shown in the "Porta Maggiore" at Rome. The most elaborate works of this character were built under the reigns of the emperors from Augustus (the nephew of Julius Cæsar) to Nero; the emperor Claudius having the honor of constructing two of the most celebrated of these Roman aqueducts, the Aqua Claudia and the Anio Novus, while the pont dungard, for the water supply of Nismes, was built in the days of Augustus, under the supervision of his nephew Agrippa, once Aedile of Rome, and under whose administration most of the best sanitary works of the city were constructed. This remarkable work of the Romans in ancient Gaul, exists to day in a state of excellent preservation, and is the wonder not only of travelers but engineers, who have been so fortunate as to visit and examine it. "Next to the Coliseum at Rome, it is considered the most perfect piece and the grandest Roman architecture now standing in the world."

This structure forms part of the aqueduct to convey the water from the springs of Arian to the town of Nismes, and spans the valley of the river Gardon, on three tiers of arches, the lower tier containing six arches of seventy-five feet span; the second tier containing twelve arches of seventy-five feet span; and the upper tier thirty-six arches of about nineteen feet span; above the upper tier of arches is built the aqueduct or water-way proper.

Other magnificent works of this character by the Romans are are to be seen in the neighborhood of the town of Segovia, Spain, one an aqueduct two thousand four hundred feet long, contains two tiers of one hundred and fifty-nine arches each, rising at the center of the valley which it crosses, to a height of one hun-

dred and two feet, and another at Tarrogona, Spain, where the aqueduct is eight hundred and seventy-three feet long, and eighty-three feet high at the deepest part of the valley.

As an illustraion of the lavish hand with which water was supplied under the rules of the Roman Empire, it is sufficient to remark that the consumption in the city of Rome in the days of Nero was as high as two hundred gallons per capita per diem.

The average daily consumption for all purposes in the cities and towns of the United States furnished with water-works, will fall below sixty gallons per capita, while in the cities and towns of Europe, the daily consumption is on an average less than half of ours.

We are all accustomed to read with admiration of the prowess and ability of the Romans as statesmen and soldiers. Should we not much more respect and marvel at these stupendous works of sanitation which have come down to us living monuments of the skill and perseverance of the Roman engineers.

The water-works of the Romans (like our own) were constructed solely for the purposes of domestic and commercial supply, but in some parts of modern Spain, France, Italy, and in Hindoostan, immense engineering structures have been raised for the storage and distribution of water, for the purpose of irrigation as well as domestic supply, which works are on such a colossal scale as to dwarf anything of like character in this country.

In France the masonry dam across the valley of the Furens River, near St. Etienne, and the Ternay dam across the valley of the Ternay River in the province of Ardeche, are among the most magnificent structures of rubble masonry in the world. These works serve a double purpose: in storing the water during heavy floods and preventing inundation below, and also to impound water for the use of the towns of St. Etienne and Annonay during the season of drouth. The Furens dam has a height of one hundred and seventy feet at the center of the valley; the Ternay dam has an extreme height above the thread of the valley of one hundred and twelve feet. The Furens dam is especially celebrated as the first masonry structure of this kind which was built upon strictly scientific principles; and the profile or cross-section has, with slight modification, been adapted by the engineers all over the world for similar structures.

But the marvels of ancient works of this character are found in Hindoostan and in the Island of Ceylon. One dam for the storage of water in the former country is made of earth, and has a length over the top of the embankment of more than thirty miles This dam or embankment has been in service for four centuries On the Island of Ceylon we find a dam constructed of blocks o stone strongly cemented together, fifteen miles in length, one hundred feet wide at the base, forty feet wide at the top, and nearly one hundred feet high. This stupenduous work of the Singalese, contains in round numbers thirteen millon seven hundred thousand cubic yards of rubble masonry, and at the prices which we are required to pay for such work now, would cost over one hundred millions of dollars; The public spirit, the intelligence and indomitable enterprise of the ancient monarchs of India, is no better attested than by these wonderful works, before which many of our so called modern enterprises dwindle into insignificance. These dams and embankments were built under royal orders, to prevent innundation of the fertile and populated lands of the lower valleys during the seasons of the greatest rainfall, and to furnish water for irrigation and domestic uses to the inhabitants of the country and towns below the reservoirs during the periods of low rainfall and drouth. The impounding or gathering reservoirs above the dams were called tanks, and of these more than forty-three thousand were at one period in service in Hindoostan alone.

You are all no doubt aware that the water supply of New York city is obtained in the same manner, by impounding at Croton Lake and near the head of the Bronx river in Westchester county the water which is gathered as available rainfall on the tributary water shed, and delivering this under gravity pressure, through the Croton aqueduct to the city.

Water-works are usually constructed to meet the domestic wants of a community and provide protection against fires, although in a few cases in this country works have been built exclusively for fire protection, the inhabitants of towns where such works exist depending upon their private wells and cisterns for their domestic water supply.

There are several general modes of construction of water-works for public water supply, the system generally depending upon the natural conditions of the topography or geography of the town. When water in sufficient quantities can be gathered or impounded in large reservoirs, at an elevation above the town sufficient to furnish a pressure for domestic, and if possible for fire purposes, and be delivered by gravity to the consumers without the employment of pumping machinery, then this—which is known as the "gravity system"—represents usually the least expensive works to construct, and by far the least expensive to operate, all expense for fuel, labor and repairs of pumping machinery being entirely avoided. Gravity water-works are frequently met with in the New England States and in the mountainous districts of New York, Pennsylvania and Virginia. Few cities of importance being located in the hilly and mountainous regions, the examples in this country of the gravity system are comparatively few.

Next to the gravity system comes the combined pumping and reservoir plan of water-works, such as we have in the city of Cincinnati. This mode is resorted to in those cases where elevations in or near a town may be sufficient to furnish a fire and domestic pressure, but having no water shed lying above such elevations to supply an impounding reservoir with water. Taking for example the elevated ground of Eden Park and Mount Auburn, while these offer fine situations for reservoirs, there is no tributary water shed at all; these elevations representing the points of greatest altitude in the purlieus of the city, and both being mere peaks or bluffs. Nearly all the cities and towns lying along the Ohio River above Louisville, and on the tributaries of the river in Pennsylvania, West Virginia and Kentucky, have elevations sufficiently near for the location of tanks or reservoirs.

Next to the gravity system of water-works, the plan embracing pumping machinery and reservoirs is to be preferred, for in this the reservoirs may be and usually are proportioned for several days supply of water for the community, and the pumping need not be continuous. In some instances the pumps are operated for only one or two days in a fortnight, or until the reservoir is filled, when they are stopped until the stored water is drawn down several feet, and then the pumping is resumed to refill the reservoir.

Some works are built with stand-pipes, or tanks which carry several hundred thousand gallons of water, the height of the stand-pipe being usually sufficient to furnish fire pressure, and the capacity such as to permit of stopping the pumping machinery for several hours at night, and perhaps for the entire night. The largest stand-pipe tank in the world, is found in the water-works of Sandusky, Ohio. This water tower is thirty feet in diameter, and one hundred and eighty feet high, in the center of which is a smaller stand-pipe (for fire purposes), three feet in diameter, and two hundred and ten feet high. The water-works of Chicago are of the stand-pipe type, while the water-works of Milwaukee are of the reservoir and stand-pipe character combined.

The water-works of Cincinnati and St. Louis, are of the pumping and reservoir class, while the works of Louisville and Cleveland contain both reservoirs and stand-pipes. The low service works of St. Paul, Minn., are gravity works, the sources being Lakes Vadnes and Phalen, which occupy elevations sufficient to furnish a pressure of seventy pounds at the fire hydrants in the lower parts of the city.

The fourth plan of water-works is the direct service system, so largely and successfully introduced in many cities and towns several years ago by the Holly Co., of Lockport, N. Y., and known in many places as the Holly system. This system dispenses with reservoirs, tanks and stand-pipes, and pumps the water from the source of supply into the mains direct to the consumer. The pumping machinery being always in operation, and the pressure

being maintained at thirty or forty pounds for domestic supply, and the pressure raised to ninety, or one hundred, or even one hundred and thirty or one hundred and forty pounds for fire purposes. The water-works of Buffalo, N. Y., are of the direct service system. Likewise at Columbus and Dayton, Ohio, Peoria, Ills., Memphis, Tenn., and many other places. Direct service works are less expensive to construct, by reason of the omission of the expensive adjuncts of reservoirs and water towers, and it is principally due to this fact that so many works in the smaller cities and towns have been built during the past twenty years.

Water-works for public supply (excepting of the gravity type such as were built by the Romans), were with few exceptions unknown previous to the invention of the steam engine; the city of London was supplied with water through wooden pipes before this date, the pumping being done by tide wheels located at London bridge.

The ancient city of Babylon, it is believed by archæologists, was supplied with water pumped from the Euphrates by current wheels; in this way the famous hanging gardens of Semiramis were watered; each terrace being supplied with pipes, probably of wood (although the ancients understood the manufacture of lead pipes of small diameter), through which the water was distributed over the grounds.

[Mr. Hill's discussion of this subject will be continued in the next number of PAVING AND MUNICIPAL ENGINEERING.]

TESTS OF PAVING MATERIAL.

Editor of Paving and Municipal Engineering:

IN response to your call for suggestions in regard to a uniform scheme of thorough tests of paving material, I would submit the following for testing stone (natural or artificial), and brick:

1. In compression—stress being applied continuously and gradually.

2. By concussion—by dropping weights upon them. This test would determine their brittleness and their power to resist sudden shocks.

3. Porosity.

4. By Hacking.—In this test I would use some means of cutting the brick or stone, with some instrument of about the same degree of sharpness, as a common trowel, a weighted knife dropped a known distance and determining its action, and number of strokes necessary to cut a certain amount, would be a very important test. One of the most worthy tests, being easily and quickly made, is to take a sample and hack it in two with a trowel. If it scales and splits off, you may know that it will act the same way under traffic, and a little practice will soon enable you to determine its relative hardness and toughness.

5. Grinding on stone to determine its toughness.

6. Polishing.—Determine the angle of friction between a sample and steel or iron, and then after rubbing two samples together a stated time under known pressure, determine their angle of friction, which would show their tendency to polish.

7. Tumbling—by putting samples in a cylinder with sharp castings and determine their loss.

8. Determine the relative "noisiness" of samples by laying the material in the same manner as laid in the pavement and dropping steel or iron weights on them and measuring the distance the concussion can be heard.

These tests would, I think, about cover all the essential tests, unless it would be the "freezing," which would hardly be practical. The bicarbonate of soda test might be applied, but would hardly justify the undertaking.

HIRAM PHILLIPS, C. E.,
Eng'r Dep't Mo. University.

ANOTHER PLAN FOR MAKING TESTS.

To the Editor of Paving and Municipal Engineering:

GENTLEMEN—Accepting your invitation to submit for practical tests of pavings, permit me to suggest the following: That at Indianapolis six blocks, or six divisions, of equal length, aggregating twelve hundred feet, be selected by the committee; place upon the whole a uniform foundation of limestone macadam, or limestone Telford, or limestone native cement Beton, or limestone Portland cement concrete, or limestone Portland cement concrete interlocking, double-lever press blocks, as the committee may select.

On division "A," pave with granite-quartzite blocks.
On division "B," pave with Eastern granite blocks.
On division "C," pave with best sheet asphalt.
On division "D," pave with granite-quartzite selenite macadam.
On division "E," pave with best paving brick.
On division "F," pave with best cedar blocks.

Explanatory of location: The street to be used for tests should be such as will lie in and from the business section of the city, hence, permitting the arrangement by which granite-quartzite blocks, being the hardest of all material, would get the most exposure. The top of the foundation would be every where the same, but, as in case of asphalt, etc., they would gladly put on a *sub-top*, to adjust the thin wearing coat to general conditions.

To meet actual expenses only, let the committee select a division where the city has laid an assessment. Secure a five-year guarantee for repairs or re-paving, each company to have its own methods subject to the specifications and the orders of the city engineer of Indianapolis. I can not conceive of a more positive good than such a test would insure.

W. L. S. BAYLEY,
Civil Engineer.

CHICAGO, Jan. 22., 1891.

ONE WAY OF TESTING BRICK.

MR. A. O. JONES, on the question of testing paving materials, suggests the following method for brick:

First. The brick should be very carefully weighed on oz. scales either when coming from kiln or carefully dried first. They should then be placed in water for twenty-four hours, and again weighed, wiping surface moisture off first. This will show its absorption qualities.

Second. Take a number of brick and weigh again. Then put it into a foundry cleaner, and put in several pieces of rough castings, and rattle away for fifteen or thirty minutes, after which take out the brick and weigh them. This will represent the stamping or walking of heavy horses traveling with heavy loads and rough-shod.

THE HIGHWAYS OF NEW YORK.

To the Editor of Paving and Municipal Engineering:

Road making and repairing is something in which I am greatly interested, and I think no state in the Union has poorer laws than New York. A general waking up may reach us. I, as an individual, *think* I do my full share. As an overseer of highways I have seven and a half miles of road, all through woods, to keep in repair. Quite a large item of repairs is clearing the road of fallen trees after our wind storms. The whole amount of taxes for this purpose is about $160—each year—that is, for all repairs including new culverts, breaking roads in sward and clearing out trees. You can imagine how much would be done in the ordinary way of working road taxes by the town commissioner, who would be obliged to hire men, build a camp and work ten miles from his home. He must wait the convenience of the *voters* who elected him; when they can not do anything for themselves, they are ready to *play* at road making and be paid for their playing. I am right glad to see a general waking up. The movement may extend east and in time we may drive from the Adirondacks to Indiana over a good wagon road.

A. R. FULLER.

MEACHAM, N. Y., Jan., 1891.

PAVING AND MUNICIPAL ENGINEERING

A Journal Devoted Specially to Street and Sidewalk Paving, Sewerage, Water-Works Construction, Street Lighting, and all Matters Pertaining to Municipal Engineering.

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Communications are invited, and all requests for special information on the subjects treated by this journal will receive careful attention.

Articles relating to the different branches of municipal engineering are desired. Stamps should accompany manuscripts for return postage if unavailable.

The columns of this publication are open to the discussion of all subjects relating to paving, sewerage, water-works, street-lighting, and the physical improvement of cities. Practical information as to the merits of materials used in such work and new methods, with photographs and drawings, which may be used for illustration, are especially desired. We are glad to get brief notes as to proposed improvements and the letting of large contracts.

City engineers are requested to send us as early as possible copies of their annual reports, which will be given proper notice.

Articles relating to methods of road making and maintenance are invited.

THE article contributed this month by Mr. Gibson, our foreign representative, gives attention to a subject which receives too little consideration in our own country—the care of streets. We have some fairly paved cities, which appear only to have prepared a solid foundation for mud. Repairing and cleaning of streets is next in importance to paving, and to neglect it is both indecent and wasteful.

IN this issue will be found several communications on the subject of tests for different kinds of paving. They came in response to the invitation to readers by PAVING AND MUNICIPAL ENGINEERING to offer their ideas as to the tests that should be made if the project of the Paving Exposition managers is carried out. The committee has taken no further steps, but is waiting for all suggestions that are likely to be offered, and will avail itself of the assistance of this publication in drawing them out. Various methods have been proposed, and the committee is encouraged to believe that, with the advice that is being offered, it will be able to devise a system of tests which will be as near equally fair as can be arranged, if it is found advisable to undertake the project, which is yet an unsettled question. There is much relating to the matter to be considered, and if it is not possible to make tests which will apply alike to the merits and defects of the different kinds of paving, it would be better not to undertake the project. The committee which has the matter under consideration should proceed slowly and carefully enough to be sure that it is right. This it is doing. In the meantime the discussion of the subject is in order, and is sure to be beneficial.

THERE is probably not a state legislature now in session that is not considering highway improvement bills. It is lamentable that many of them are of the old kind and are of the patch-work pattern. The old highway improvement system is so radically at fault that it can not, by amendatory bills, be made good enough to meet the requirements. Not until there is devised a system of improvement which provides for constant attention to the repair of roads, and which requires that those who have charge of the work shall have proper instruction as to their duties and shall be under the general direction of experts, will there be any notable advance in making the highways of the country better. An idea of what is essential is suggested by Professor Landreth, of the Engineering Department of Vanderbilt University, who says, "The science of road-making and maintaining, though neither difficult nor abstruse, is nevertheless based on principles so well established and so unvarying in their operations as to render their thorough comprehension an essential to success in securing and maintaining public roads at once efficient and economical, whatever the administrative system by which they are constructed and controlled. In other countries the superintendence of public highways is recognized as an important and responsible duty, and is usually assigned to *specially trained expert* government engineers, while in the United States, where the greater mileage makes the economy, if not the efficiency, of roads even more important than abroad, the states depend for this responsible service on private citizens, locally and temporarily appointed to the duty without providing for them the technical instruction and training so essential to success under any system." In Tennessee, Pennsylvania and New York bills have been prepared which will, if enacted, result in better road-making, and there is now pending in the Indiana legislature a measure which proposes an advanced system such as we have advocated. It provides for the appointment of a state board of highway commissioners, with one chief engineer and three assistants, who shall devise the road improvement system of the state and shall give instructions to the local supervisors as to how their work shall be done. It requires that institutes shall be held, for the purpose of giving this instruction, in different sections of the state each year, and provides fully for systematic work and continuous attention to repairs. While in none of the states mentioned have the pending bills been passed yet, there are indications that some of them will become laws, and there is encouragement for the belief that an era of substantial improvement in road-making and maintenance is about to begin.

PAVING BRICK DISCUSSED BY THE N. B. M. A.

There was no subject considered at the recent meeting of the National Brick-makers' Association which seemed to awaken greater interest than the discussion of "Paving Brick Interests," led by Mr. A. O. Jones, of Zanesville, Ohio. In the beginning of the discussion Mr. W. A. Eudaly asked that all now interested in paving brick, or who thought they would be during the next year, rise to their feet. A large number of the members of the Association stood up. Mr. Jones took the place on the programme of Mr. R. C. Burton, of Zanesville, who was unable to be present. His paper and the discussion following it are given below:

Mr. President and Gentlemen of the National Brick Manufacturers' Association:

It is with considerable timidity that I make the attempt to substitute another to say a few words on the rapidly growing subject of the "paving brick interest." As this is comparatively a new branch of the clay industries, it is somewhat easier to get off with lighter criticism than on a somewhat older subject.

It is the most modern, and decidedly the most important addition to the craft of the present age; it is no longer an experiment; its here to stay, and you may count with perfect safety that it is the coming pavement of this country; not only in the cities, and towns and on boulevards, but will be adopted eventually for our country highways. This may seem extravagant to those who have given the subject but a passing thought, but let the farmer see the day that he will get a reasonably good price for his commodity and that he can't afford to spend a whole day to take half a load to market, when he sees that he can by paving his share of highway, and that the outlay is only what it cost now to keep up a miserable excuse and uncertain roadway for say ten or even fifteen years; that by this outlay he will be able to take two or more full loads to market and get his meals at home, and have a road that he can with certainty make his journeys on without accidents, then the farmers' league and the grangers will say, there is nothing like bricks, and they will rise up with one accord and call you blessed.

The first streets paved with brick in this broad land are not more than a score of years old, but the combined arguments of christendom could not prevail on those cities to return to their old mode, or any other kind of pavement. True, some of them were not so good as they are made and constructed now. We have yet many an error and imperfection to surmount, which we see by the almost daily improvements that follow one after the other, both in the manipulating the material in its various conditions and mixtures, but also in the actual laying of the pavement.

It is said that "necessity is the mother of invention," but sometimes other circumstances bring about good results. Had not the fire brick bats and clinker brick pile accumulated to a formidable size about a Wheeling rolling mill they would not have thought of getting rid of them by paving the wagon ways about the mill, but after they had been down for some years, and stood the test better, longer and without any repairs than other material, then some attention and investigation followed. The result was streets were paved and a new era began in that district.

Galesburg, Illinois, from great scarcity of road material, tried brick, which fortunately stood well, and now has increased their manufacture to an enormous quantity in the west.

There is every reason to expect this paving brick industry to grow to an almost unlimited magnitude, as the majority of good building brick clays, with different treatment, will make fairly good paving brick for light travel. But to stand the wear and traffic of large cities, and to equal granite and other high priced and expensive pavements, there must be a careful selection of clays, such as semi-fire clays, or some of the shale clays, that will stand a high degree of heat, so as to become thoroughly vitrified, and at the same time have that toughness that is necessary to stand the continuous friction of heavy loaded teams from and to the freight stations and boat wharfs.

As to the ideal mode of making the best paving brick I shall refrain from the attempt to describe it. But among the most extensive in use in Ohio is after the same manner as preparing the clays for the manufacturing of sewer pipe. After the clot or brick is formed then repress, for unquestionably this densifies the body. It takes a little more fuel, but adds greatly to its lasting qualities. It gives it a finished look, some workmanship; add to this perfect burning, for this is of the most vital importance. The best results so far, to my knowledge, are from that class of kilns best known as the down draft, for with these you can retain the heat and allow your brick to anneal and toughen; then with a proper foundation for them and carefully laid you will, in twenty or fifty years to come, find them stuck together true and faithful as nothing else can, under as many adverse and varied circumstances as a true brick.

PRESIDENT ADAMS—There will be no more interesting question before this convention than that now under consideration. There are a great many present who are interested, and I would like to hear from some of them.

B. W. BLAIR—I would like to hear from Mr. J. G. Shea, Decatur, Ill.

J. G. SHEA, Decatur, Ill.—Gentlemen of the convention, I presume there is very little that would be new that I could give you on the subject. Now, what constitutes a good paving brick? Any brick that is very dense; that will not absorb water. Of course if you exclude water you exclude frost, and that is the great enemy of brick streets. Now, as to the quality of the clay. Mr. Jones, in his paper, says it should be some kind of shale or fire clay. I admit that you must burn the brick very hard to make a good paving brick, but the further you can get from fire clay the better the brick. I have some sample brick here. This [holding one up] is a vitrified brick. It has B. W. Blair's name on it. I made and dried that brick in two days, and burned it with my own brick. Put that brick down in Cincinnati or Indianapolis and it will last twenty-five or thirty years. The clay that will make paving brick is not as scarce as you might imagine. It will be discovered when the demand for paving brick rises. We have made brick of two kinds of clay. Some kinds of clay will not make paving brick at all. I have seen some clays from this state that would not vitrify at all. Now, the next question will be what kind of clays, quality and all that will vitrify. That is something that is being discussed all the time. Next, as to the size of brick. There are about as many varieties of sizes as there are kinds of clays. Now, the question which is the best size. Some will say time will tell. How is time going to tell when we all make paving brick that will defy the ravages of time? We have to take time by the forelock and decide for ourselves. I have come to the conclusion that a common building brick size is the best size and the most profitable size for the paving brick, for the following reasons: First, it is very much easier to burn small brick than large ones. Next, I don't think they have ever invented a kiln that will burn brick exactly alike. I have never seen one. For that reason there will be waste in the best of kilns, and if you have a common building brick size, the softer brick will sell very rapidly for building purposes. No question about that at all. If a larger brick is made they can be used for paving purposes alone. Another point about size. It is very much easier to repair a street, in case you have to make repairs. If you lack a brick or two in making repairs it will be very easy to go to any kiln and pick out the right size of brick. Well now I will pass on the manner of laying. That, I think, is really as important as any other feature. We are about as badly divided on that point, perhaps a little more so, than any other. In Illinois, where I live, in nearly all of the cities we use two layers of brick. For a foundation we use about four inches of gravel or good sharp sand; then lay on the flat a course of good hard sidewalk brick; then two or two and a half inches of sand and vitrified brick on top of that on edge; put on good sand, brush it in the crevices and tamp down with a heavy mall; put on about half an inch of sand and throw it open to the travel. As horses are driven over this pavement they are continually tramping that sharp sand between the brick, and it soon gets like rock in hardness, and after the first winter's use it is just as hard as cement every bit. There is nothing equal to sand; it will keep the water from going in. We first made our grade rather steep, six inches on a forty foot street, but we now make it in Decatur, Ill., and other places three inches. It looks almost flat, but it carries the water off. About four inches would be better than three inches. Any one acquainted with cities where they have that kind of paving can almost any day go into any street and find a place where the street is torn up. They will find the layers of brick and sand as clean and dry as the day they were put down. We have proved that by several years experience. There is another point in favor of this manner of laying brick.

If you will take cities that have streets that are to be improved with bricks or any better paving material than they have, gravel or cobble-stone streets, by adopting this layer of gravel and sand, and a lower course of bricks, you can utilize the gravel already in the street. It will save that much time, and you can get a good foundation—I will say as good a foundation as you can make. It is all there, and you don't have to put it down another time. Now, I have nothing to say against a macadam pavement, but it is unnecessary, since we funish as good a foundation as any street needs. If I were to call on a brick-layer, and ask him what kind of foundation I want for a one-story house, and he would say 16 inches, he would get solid foundation, but 8 inches is good enough for a one-story house. It may be that 16 inches is better, but I don't admit it. I claim that a foundation that is already made in the street, where brick streets can be introduced, is good enough, and all you have to do is to try it, and you won't have to try another kind, and it seems to me the paving brick interest can be advanced more by the fact that old foundations, if in existence, can be used than they can by anything else. Anything that will cheapen the cost of paving, and give us a fair price for our wares, will introduce the brick into common use.

MR. BEATTIE, Atchison, Kan.—In the first place, I want to say I am not here to condemn any brick brick that would do for street paving. I contend that the very poorest brick that is being put into streets is better than wood any day. I think there are some paving brick made that are better than others. When I started in this street paving business, the first thing we had to fight was wood pavements. We have overcome them. The next enemy we had to encounter in the street paving line was asphalt. We have met asphalt in a fair fight and conquered that, and we are competing with granite paving now. We are making brick to-day that is as good for street purposes as any granite that was ever used in America. The Board of Public Works, Omaha, Neb., have given out a report that says the only material they are going to use hereafter will be vitrified brick and granite, and after we have had a few encounters with granite I think we can knock that out. The brick we are making in Atchison, Kan., are made of blue shale clay; it is very hard. We have to use dynamite to blast it. We became interested in that industry by the Galesburg people sending in some brick of theirs to pave streets, and we took our clays, had them tested, and they proved satisfactory, and we entered into the manufacture of paving brick. We use a Galesburg dry pan and have a Wallace pug mill and a Penfield machine, and burn them in a down draft kiln of Eudaly's. I am not only making brick, but laying them down in the streets. We have some six or eight miles of streets paved with brick in Atchison. There is not a sign of wear on the streets which we put down. There is no depression except where they may have put in their water mains and did not tamp it down well afterwards, but in streets where there has been no tearing up there are no depressions in all those miles of street, proving conclusively, in my mind, that there is no use putting concrete under brick pavements. One advantage where you use two courses of brick is you can select all the misshapen brick or those that are a little too crooked or too soft; they will do just as well as the very best and hardest brick. Any brick that will not disintegrate will do for the bottom layer. We use four inches of Missouri river sand in the bottom. One course of brick laid on flat, one inch of sand, then one course of brick laid at right angles with the street, on edge. Then roll the street with a heavy roller and scatter some sand over the top. I claim that a brick that requires pitch is not fit for street purposes. You have to make a brick that is impervious to water and will stand immense pressure. Engineers, who have given the subject a great deal of attention, say a brick that

will stand 6,000 pounds pressure to the square inch is a good paving brick. Our brick stand on an average 12,000 pounds to the square inch or 135,000 pounds for the brick. I was not there when the test was made, so I can not be accused of doctoring it in the least. Some claim that a hard brick will make a good paving brick. Well, it will make a pretty good street, but where you come to have streets that have an immense travel, gentlemen, you will have to make a vitrified brick. A hard brick, after the crust is broken, will wear out very fast, indeed, where there is a great deal of heavy traffic on the street, but where they use a thoroughly vitrified brick, instead of the wheels of the wagons or horses' feet affecting the brick, you will see pieces of iron and steel on the street where they have come in contact with the brick. Brick pavements were almost a complete failnre on the opposite side of the river, and we went down there and prevailed on them to pave a street with our brick, and it has given such good satisfaction that I think there will be a big boom in brick pavements in that city.

MR. SHEA—I was just getting warmed up when I was stopped. If there is any gentleman in the room who would like to ask me any questions, I will gladly answer them. I have given a great deal of time and attention not only to making brick, but to laying them. I am one of the men who advocates that the man who makes the brick should lay them. Now, my reason for that is this: I think it is best, where it is practical, for the men who are making the brick to be at least interested in the laying of the brick. I have always made that one of my rules. Sometimes it was not possible for me to do it.

MR. PURINGTON—You speak of a hard brick and a vitrified brick. What is the difference, according to your ideas?

MR. BEATTIE—I have never seen a vitrified brick made out of shale that was not fit for a paving purpose.

MR. PURINGTON—I am not speaking about shale. Must a paving brick necessarily be vitrified?

MR. BEATTIE—No. There are some vitrified brick that are so brittle that when the wheels come in contact with them they wear off, or spall, as you might call it, very rapidly. These brick are not good paving brick. It must possess toughness with vitrifaction. If not, you have not a good paving brick.

MR. SHEA—Did you ever see such brick spall, if they were thoroughly vitrified?

MR. BEATTIE—No.

MR. PURINGTON—Does it make any difference what the process of making a paving brick is, so it be made in the form of a brick, so it be thoroughly vitrified, whether dry press, stiff mud or soft mud? Does it make any difference in the quality of the brick, when it is thoroughly vitrified, how it is made?

MR. BEATTIE—Yes. As far as my experience goes, the best paving brick I have seen were made by the stiff clay process. I am not interested in the sale of any machine. There was a plant started in our section to make brick by the dry clay process, and it was a dismal failure. There may be clays that will make brick by the dry process that will do for paving brick, but for my part I have never seen them.

MR. PURINGTON—If a brick is thoroughly vitrified it must be a highly heated mass melted homogeneously in one mass. Will dry press brick vitrify?

J. G. SHEA—I will answer Mr. Purington's question. I have vitrified dry press brick and got just as good brick as I have ever seen.

MR. BEATTIE—The clays I am working will not do it. I have never seen it done to my satisfaction.

B. W. BLAIR—Is it necessary to sand brick?

MR. BEATTIE—A brick that needs sanding is not a good brick.

A MEMBER—In case you strike a soft foundation in your road, what would you put under your brick?

MR. BEATTIE—If it was not too deep I would remove that soft place and put in stone or cinder. After the whole street had been filled, I would certainly put in concrete and as heavy a bed as I could be allowed to put in. But the reason that I am an advocate of sand is that in street paving you not only want something that is hard on, but has got elasticity to it, something that you are not continually pounding against. By using sand you get cushions below the brick that make the pavement hard on top, and yet an elastic pavement underneath. That is why I am an advocate of sand in preference to concrete foundation.

B. W. BLAIR—One more question—Which do you prefer, a round-cornered or square-cornered brick?

MR. BEATTIE—I prefer a brick that is almost square, for the reason that the brick will not wear off between. If the edges are close there is no danger of the brick chipping. That is my experience. If there are any other questions I would be pleased to answer them. I believe that the manufacture of paving brick is going to be one of the greatest industries in clay manufacturing we have in this country.

MR. ANTHONY ITTNER—I arose, Mr. President, in answer to your invitation to members who are interested in the manufacture of paving brick. I am not engaged in the manufacture of street paving brick, nor do I at present expect to be, yet I may be before the season sets in, for we can not tell what a day may bring forth. There are a few thoughts that I want brought out on this subject, and it is for the benefit of those engaged in the manufacture of street paving brick. I believe, as the last speaker has stated, that we will all live to see granite taken up and brick put down in its stead. Mr. Jones says that paving brick has come to stay. I hope so, but that depends on those who are engaged in the manufacture. [Applause.] It has come to stay, but how? As an infant in swaddling clothes, or as a robust, vigorous man? Let me go back to the last convention we held in Philadelphia. There was an esteemed brother there from St. Louis, who got up in that convention and said that paving brick could be made by the proper manipulation of any clays. I did not care to discuss the subject, but, coming from the same city, I felt if I remained silent I would be regarded as indorsing that proposition. I, therefore, got up and stated that I had attended every convention of the National Brick Manufacturers' Association, but that a more fallacious idea had never been presented in this convention. I further said, you can not make a silk purse out of a sow's ear, and those who think they can will have a big failure if they make the attempt. I said that no kind of clay that has not got in it the elements of a street paving brick will make a good paving brick by any manipulation in themselves. It may be that by getting a certain per cent. of other clays and mixing them with it you might arrive at satisfactory results, but you can not do it by any manipulation of the clay itself, and I speak of the clays in and around St. Louis, from whence I hail. Vitrifaction does not help such clay; it harms it. After it is vitrified the brick will not stand the traffic of our heavy-laden streets in large and populous cities. If you take a brick and vitrify it through and through and put it down on the street, in less than a year it would be ground as fine as powder. I am not in favor of wood, granite or asphalt, because I have seen them tried to my own satisfaction, and concerning that which I have seen with my own eyes and know to my own knowledge I am fixed, and I am fixed on those three. I want to say a few words upon the way and manner in which paving brick should be laid down in the streets. I have observed these matters very closely. In laying your brick you should lay them at an angle of 45 degrees, so that the wheels could move from one brick to another without concussion. The riding will be easier, and the pavement will last longer.

The fifth and last session was called to order at 2:30 P. M., Thursday, by the president.

PRESIDENT ADAMS—When we adjourned this morning we had under consideration the discussion of the "Paving Brick Interests." If there are no objections we will take up that question where we left off this morning. We would like to hear from Mr. A. O. Jones, of Zanesville, Ohio.

MR. JONES—I don't feel very much like speaking now. I was warmed up this morning, but I am cooled off now. I believe we left off where Mr. Ittner said a vitrified brick would not stand or make a good paving brick. I want to differ from him a little there. It may not do to vitrify St. Louis clay. There is nothing that will do for paving if it is not a good brick that is vitrified. Any brick will absorb water unless it is vitrified.

PRESIDENT ADAMS—Mr. Ittner did not refer to all vitrified brick, but brick made from St. Louis clay.

MR. JONES—There was one foundation which one gentleman suggested this morning would do for a pavement. Now, in cities where there is very heavy travel the question is whether that foundation would answer. Our pavements in Ohio are made as follows They are laid down on a solid foundation, filled in with eight to fifteen inches of broken stone, rolled with a twelve to sixteen ton roller, then a layer of two or three inches of sand is placed on the broken stone to act as a cushion. Where there is extremely heavy traffic it is necessary to put in extra heavy foundations.

MR. J. G. SHEA, Decatur, Ill.—I will say in regard to sand foundations, it has been tried to my knowledge in the west and for a good many years in Bloomington, Ill. They have put in the brick in that way and they have no trouble with the foundation. The brick have been there for eighteen years, and they are wearing off a little at the edges, like granite blocks, laid down in cities, but I don't think there is any trouble about the foundation at all, and we have miles of that foundation in streets where sometimes there are heavy wagons and threshing machines that are very hard on the brick, as the little projections on the wheels will cut almost anything. They never sink except where they have dug for water or gas mains.

I read an article in a little pamphlet published by the gentleman who got up the paving exhibit in this city last year. It was a testimonial letter from the city engineer of St. Joseph, Mo. He advised a layer of four inches of sand, and then put the brick down edgewise. I didn't suppose you could get a good foundation in that way, but that engineer says that the St. Joe people are well satisfied with it. It is necessary, I think, to have two courses of brick.

I have tested 250 clays from different parts of the United States, and I will say nothing at all further than I said this morning. There is something I do want to speak about, however, and that is our laws. I think all gentlemen who are interested in introducing brick streets should look into the special assessment laws of the cities and states where they reside. I only know about the states of Illinois and Indiana. I have had contracts in both states making streets, and I posted myself on the law. In Indiana they have a splendid law; it is a special assessment law. It is called the Barrett law. It is all that could be desired on the subject. I do not think it could be improved. It is very just to the property owner, the contractors, and material men, and will tend to encourage improvements. I am sorry to say that we have about as bad a law in Illinois as we could get up on that subject. It appears to me that if they had called in a council of Fiji Islanders to frame the law they could not have done worse. There is one more subject of which I desire to speak. I refer to that little band of hostiles which is still on the war path fighting brick paved streets. These hostiles are holding their meetings on the cobble-stone streets of their wretchedly paved towns or would-be cities, but when we shall meet in that big wigwam on the shores of Lake Michigan two years hence, they will wash their feet, and come in and take us by the hand and say that our wisdom was superior to theirs. They will perhaps say, we will join you in laying the foundation for a higher civilization, so that future generations may not have such a rough road to travel as we have. [Applause.]

B. W. BLAIR—There is one idea I heard expressed here on paving brick that I think has emanated from my old friend J. M. Bushong. His idea is that you want to just get at the point of vitrification in burning.

MR. J. H. FAIRHALL, Grape Creek, Ill.—As a manufacturer of paving brick and paving blocks on a large scale, I am much interested in this. There is another thing, it seems to me, we ought to mention, and that is what is the best test of paving brick. We all know, as brick-makers, when we look at a brick, whether it is a good one or a bad one, but are we so sure of the best test to determine what is a good article to put down on our streets? There are a great many dry press brick men here, and I would like to hear from them. I have myself made bricks on the dry press machine that I think as good a quality for either paving blocks or bricks as any plastic brick I have ever made. I have made both, and know of what I am speaking, but I will say we have never used them for paving brick, but I consider that they can be used. I am in favor of plastic made blocks for paving. I believe the block is coming into use. I know I am bringing a storm down upon my head. I know my friend Purington is getting ready for me. The block being larger, it is cheaper to lay and is

cheaper to the city that lays it in the long run. Each block that is 14 by 5 by 4, if it is properly burned—and it can be—will stand a great deal more than a small brick will. It will stand a greater force amount of abrasion, and that, I think, is the proper test of a paving brick, not the amount of blows a brick will stand, for there is no wagon wheel that will come in contact with it with a blow, but it comes with that growing pressure that tells on the surface of the brick. I don't believe a good paving brick will be worn out in twenty years. Blocks will be down one hundred years from to-day if properly laid, and that is one thing for which we as brick-makers ought to stand side by side with the authorities of the city that is doing the paving. The contractor (with all due respect to those present) is the man we have to keep our eyes on. While there are many contractors thoroughly honest in their intentions, every one is looking out for the dollars. A contractor will take your brick and lay the top brick a very hard one. He also takes a very inferior brick, that is a softer brick, and lays on the bottom course. There is such a thing as those bottom brick being laid as top brick, and that is the thing we want to look out for. We have got to see that the contracto. lays the brick we sell for top brick as such That he does not injure our reputation by putting in brick that will go against our credit. A competent inspector should be employed who will do things right both for the city and manufacturer of the brick. I have had no experience in laying brick, and, therefore, I can not speak on that topic from experience, but I have sold brick as bottom brick that have been laid as tops. It stands against our reputation as brick manufacturers, and we should all, whenever we find it, try and expose it as much as we can. It is not altogether the quality of the brick we have to look to. We have to look to our interests, and be very careful of our reputation. If there are any gentlemen here that can give their views on the dry press brick, I would like to hear from them, if they think we can vitrify dry press brick that will stand the wear and tear of the traffic on our streets, for I have a dry press machine standing idle that I might use. [Applause.]

D. V. PURINGTON—There are just one or two things that did not seem to be touched upon this morning that I want to call attention to. One of them is the comparison of brick for paving with granite, and in my judgment Mr. Ittner is correct when he says that the time will come when brick pavements will supersede granite. The objection to granite blocks heretofore has been its slipperiness. Now, brick as you all know, never wear like that if they wear at all. Such a thing as wear on a good paving brick has never been discovered, and they have been down a long time in many places. In Chicago there is but one piece of brick paving that I know of, one that was put down last March. If any of you come to Chicago I want you to see it. It is the strip running along Canal street in front of the C., B. & Q. R. R. freight depot. If any of you know a place where paving brick would be subjected to a severer test than you find in front of a freight depot in a large city, I would like to have it pointed out. Mr. Ripley, the general superintendent of the road, told me he had seen a load of heavy hardware backed up to the door, and the small fore-wheels, just as the wagon began to turn, would catch in the asphalt pavement and make as pretty a wash bowl as you ever saw, and they put down the best asphalt pavement they could get. Last March they had to take it all up and put down brick. I asked Mr. Ripley why they didn't put down granite. He said granite would wear off and the horses could not back up over a granite pavement. I saw that pavement about a month ago and it shows no signs of wear, and my judgment is it will show no more wear one year hence than it does now.

E. H. CALLOWAY, Syracuse, N. Y.—The gentleman who preceded Mr. Purington mentioned a test that is very good and necessary, that is, crushing strength of brick and resistance to abrasion or the surface wear. These are very essential, but, of course, the crushing strength does not amount to so much, because the crushing strength in an ordinary brick is sufficient to resist any crushing strain that might be put on a pavement by a loaded vehicle. But what I consider one of the most important tests was not touched at all, and that is the imperviousness of the paving brick to moisture. I shall not enter into detail on this subject, because it will come under the head of vitrified brick, but we all know that in a severe climate, such as we have in all places in the northwest and east, that brick will absorb much moisture during the rainy season, and when that water freezes in the winter it is going to expand, and is bound to cause more or less disintegration. I see a gentleman shaking his head over there, but that is a fact just the same. We have got to get a vitrified brick that will be impervious to moisture or acids. When the discussion of vitrified brick comes up I will try and demonstrate it. I consider one of the most important tests of a paving brick is its imperviousness to moisture, water, acids, or any of the fluids.

D. B. DRUMMOND, St. Louis, Mo.—I want to say a word or two in regard to the absorption of moisture by paving brick, and their manufacture by the dry press process. In preparing the clay for the dry press we manipulate or prepare the clay more carefully, so that it requires a greater degree of heat to fuse the granules of clay in a dry press brick than in a plastic brick. If we use it in that state it will certainly stand more hardship from the weather. If we take brick of the same size and dimensions made from plastic clay, and compare it with one made by the dry press process, you will find the dry press brick a much heavier brick than that made in the plastic method. Consequently, if we have a good material in that brick we certainly have something in favor of dry press brick. I think at no very distant date paving brick will be made by the dry press process. For that one reason alone, that it does not absorb moisture, and that it retains its strength, I claim that as a point in making paving brick by the dry press process.

G. S. TIFFANY, Tecumseh, Mich.—I think we are here to give facts and figures, and now if there is a gentleman here who is working dry press machines and making good paving brick, I would be pleased to have him mention it. If you are operating two kinds of clay and want to know which is making the best paving brick, taking them to the nearest foundry and put them in the furnace. If you want to test two different kinds of clay that is a very good way to do it.

E. H. CALLOWAY—I merely want to make one point. If Mr. Drummond will go with me into the exhibition room there, I will show him a brick made on a soft clay machine that is thoroughly vitrified, and I will donate $10,000 to the Association if he can soak that brick 24 hours and show any absorption, and that brick will stand 90 tons pressure.

MR. EUDALY—I wish to suggest, Mr. Chairman, as we have, further on, the subject of vitrified brick, and some of the gentlemen wish to speak on it then, that this discussion be deferred until the vitrified brick subject comes up. I think we could save a great deal of time, and inasmuch as there is a paper on this subject, I hardly think it is fair to the writer to discuss this subject now.

S. P. CRAFTS—In reference to the point the gentleman made that the top brick would absorb water and therefore be ruined by the frost in cold weather, in our vicinity we make brick which will absorb 8 ounces of water and these brick will lay out in all kinds of weather and they are not affected, though we do not call them hard brick.

PRESIDENT ADAMS—No one caring to speak further on this subject, we will take up the next paper.

VITRIFIED BRICK.

Later in the session a discussion of the subject of "Vitrified Brick" was led by Geo. S. Tiffany, of Tecumseh, Mich., who said:

MR. TIFFANY—Gentlemen of the convention, I feel somewhat embarrassed. I don't know that I have felt so since I was married. I was married by the Episcopal service, and I made preparation for it. The preacher said: "Say these words after me, 'I promise,' "—I said, "I promise,"—"'to take this woman,' "—I said, "To take this woman"—and so on through all of it. I feel myself in just about the same position at present; I have simply to say after some one what has been said before. Now, in regard to vitrified brick. I could tell you the best way, but the question is, what clay will make the best vitrified brick? I can hardly answer that. You have to ascertain that by experience and trial. The various kinds of clay are just as different as the character and features of men. What we call fire brick clays, some of them have scarcely any refractory power. The clays that are called common clays are sometimes superior in refractory power to some clays that are called fire clays.

I think that a clay that will make a good sewer pipe will make a good vitrified brick. In process of vitrifaction you want to be able to stop just before the process is completed. At that point it is liable to go into a molten state, and your whole kiln be down on your hands. You have to ascertain, if you want to make vitrified brick, by careful tests how high you can set your kiln, or else you are liable to endanger your whole kiln and lose thousands of dollars. There are many of our surface clays that are simply decomposed shale. Now, such clays take a salt glaze, as a general thing, the best because they have the proper elements, contain sufficient iron and silica, and are free from limes, etc. Take a clay that will rapidly effervesce under the action of acids, and you can not get any kind of a glaze upon it. You can also judge sometimes by the observation of the effect of fire upon your own kiln of brick whether you have any prospect of making paving brick. If the heads of your arches, the under brick, are glazed it is an encouraging sign. There was a friend of mine asked me not long since to visit his yards, and wanted to talk with me about putting in a stiff mud machine for making paving brick. I went to see his kilns and his clays, especially his clays. We went out into the yard and we examined the arches of the burned brick in the kiln. We came to a place where they were moving the brick out of the kiln, and he took a brick out of the arch and showed it to me. One end of that brick was just burned to a good hard brick, with no sign of vitrification whatever. The other end was all shriveled and burned out of shape. Now, there was not a point between the two ends, that had the elements of a vitrified brick, that was in the condition, as a body, for paving brick.

Now, there are thousands of such cases all over the country. It is absurd for any one to attempt to make paving brick out of that kind of clay. You want to begin carefully in your experiments, but it may be that it would not be profitable for you to attempt to make paving brick if you could not set them high enough in the kiln to burn properly. This, certainly, is a very important question. Now, I do not feel like discussing the question any further, after it has been considered by this convention and so many able men have spoken upon it. I feel it is almost impossible for me to speak upon it without repeating what others have said, or what I, myself, have already said at former conventions. Gentlemen, my position is a very embarrassing one, and I ask you to kindly excuse me from further comments. [Applause.]

D. O. LOY, Monticello, Ill.—I would like to ask, all things being equal, what is the difference in cost of burning paving brick and common hard building brick?

MR. PURINGTON—I do not know that I have had sufficient experience to answer that question. I will simply say this, that the first kiln we burned at Galesburg was an up-draft clamp kiln. The kiln was burned in just 40 hours from the time we set fire to it, and it was a great deal better kiln than we have ever burned in 5, 7 or 8 days. We burn 5 days now—5 days from the time we start the fire until the kiln is done. But you will see that this statement does not very clearly answer your question; because we have not been going at it long enough yet to get at the exact time of burning. We have to take the average of a period of time, not less than six months, to base the figures on. Perhaps some one else can better answer that question than I can.

MR. PIKE—I want to say that with our clays fired up to the point, which we call good, hard brick (there might be a question as to what a hard brick is) we can only make what we dominate good hard brick, brick that will do for sidewalk purposes; you hold this brick about twenty-four hours after you pass from this point and with our clay the brick will vitrify; other clays you might hold forty-two hours and then they would not vitrify. The question by Mr. Loy is, "what is the difference in cost of burning paving brick and good, hard building brick?" I would say the difference in cost for fuel from that point necessary to burn building brick to burn to the point of vitrifaction, adding the cost of the men it takes to fire the whole kiln. At least that would be our expense.

MR. SMITH—I would like to ask Mr. Tiffany if he can vitrify dry pressed brick?

MR. TIFFANY—I would like some one interested in dry press brick process to answer that question. I will say in regard to the previous question that the amount of fuel required will vary according to the properties of the clay. It takes less fuel to burn some clays to a point of vitrifaction than it does for others.

J. M. CHASE, Macomb, Ill.—I would like to ask, after it passes that point where the final fires are given would you not hold the heat as near as possible at the same point without increasing it? Would you advise increasing the heat of the kilns after that point had been reached?

MR. PIKE—In reply to the gentleman, I would say, that we with our brick in Chenoa, would finish our kilns at the point of white heat, a heat that resembles the electric light. I do not know anything about units of heat; I am not versed in that line, but our heat resembles a white heat. We continue that heat right along, the white heat, as hot as we can make it for about forty hours, and at the end of that time the brick are vitrified.

MR. RICHARDSON—There is one phase of this vitrified brick question that I would like to ask for information on. In the section of the country where I live, near Cleveland, Ohio, they are making a specialty of vitrified brick and face brick, and there are now two companies calling themselves vitrified brick companies. I was there the other day and there are two or three other companies in process of organization to make vitrified building brick out of Bedford, Ohio, shale. Some of you are familiar with this brick, because we have seen it at the Chicago convention, made by the Meyenberg Brick Co., of Chicago. This shale is very common about Cleveland. In some places it is 30 or 40 feet thick, and the question I want to know more about is, the desirability of vitrified brick for front brick in buildings. Some of you who are builders, perhaps, might know something about it. We are not making vitrified brick, and we are coming in competition with men who are making it and making great talk about this vitrified brick. This Bedford shale, in addition to vitrifying easily, makes a beautiful brick. I have been testing some clays for these parties and making them in the same way I make my own brick, and I find I have not been able to virtify these brick by setting them as high as we do, 32 courses, for they melt together so badly that we can not split them open.

I understand in Chicago, where they made a success of these brick, they found they could not set them so high, and they set them about six course high and put on a fire clay slab, and then six high again and so on. I presume that with some of these clays that vitrify so easily you will make a failure of if you set them too high. I see some paving brick here that is vitrified, and I do not understand how you can vitrify a large percentage of the kiln set thirty or forty courses high without having them melt all the way down unless you put fire sand between them.

MR. PURINGTON—It is the peculiarity of the clay. That peculiarity is found in the clay fields all over the state of Illinois. I do not believe it is peculiar alone to the Galesburg clays. I think you will find some brick here that came from there. The reason that particular clay is valuable for paving brick is it will vitrify without running. The brick made of that clay can be vitrified and yet retain their shape. This is why Galesburg clay is superior over other clays.

MR. SCHNELL—Can dry pressed brick be vitrified, without sticking together?

MR. RICHARDSON—They can. Dry press brick can be vitrified half way down, say, fifteen courses out of thirty from the top of the kiln, and not stick. I know, because I have demonstrated it to my own satisfaction. They will run sometimes, but you can vitrify them without having them run together. The pure and simple fact is it depends on the draft. You must have a high draft. I do not believe that vitrified brick will ever make first-class face brick, because it is generally conceded that a first class face brick must not have too much of a shiny appearance, and vitrifaction almost uniformly brings that shiny appearance to the face, and I do not like that appearance myself, and think it is not generally considered good.

MR. EUDALY—There are a great many gentlemen here that do not know what business I am engaged in, and I don't propose to tell them. I have looked into a great many kilns throughout the country. I have thought I could look into a kiln and tell about how hot it was, and I tell the proprietors that I would not burn that kiln any longer, and then I go about my business, and about the first thing I know I get a letter from the place that I was entirely mistaken, and then feel that I don't know anything about it, and I believe that the majority of us have come to that conclusion several times before this.

I heard, this afternoon, quite an interesting discussion between two gentlemen about burning in continuous kilns, one stoutly maintained one thing and the other stoutly maintained another. Both were right, but their clays were just as different as it is possible for two clays to be. Now, one gentleman was describing a clay that will stand any amount of heat; it was a fire clay. You can put heat to it until you burn the brick hard right down to the bottom of the kiln, and if you want to get hard brick out of that kind of clay you can do it, and get them all hard. The other gentleman was burning a kind of clay that is very delicate and takes a great deal of heat to burn the brick just the way he wants it burned, but when you get to that point the least bit more heat will ruin it, and he was having bad success with it.

So it is with all these questions of vitrification. It seems to me to be a little bit absurd—I don't like to use that word, it is a strong word—but it does seem a little absurd to hear people talking about burning brick just up to the point of vitrifaction; just up to that point, and then stopping. It does seem a little too ridiculous to me to hear a man talking about that. I heard recently of councilmen specifying paving brick for their streets, and saying they must be almost vitrified, but not quite. I think that would be rather a hard contract to fill. What I have said is simply to illustrate this; when you are talking about vitrified brick in this locality or burning with oil in that locality, or burning with coal in the other locality, to understand each other well we must have all the conditions mentioned. Mr. Purington has made a grand success in Chicago by burning brick with oil. If I were living in Chicago, making the kind of brick he makes, I believe I would use oil for fuel, and I do not believe I would burn brick unless I could use oil or gas of some kind. But I want to tell you, gentlemen, I know of a very respectable gentleman who visited Mr. Purington's brick-yard a year or so ago, and was so infatuated with the reports which he heard from Mr. Purington that he went home and was determined to burn brick in the same way with oil, and it cost him a great many thousand dollars, and he had at last to abandon it because oil fuel was not a success with his kind of brick. I know of another gentleman who visited Mr. Purington's yard, and he went home and tried to burn in that way, and it cost him several thousand dollars to put up a little plant to burn oil; he used it a short time and found it cost him more to burn with oil than coal, including labor and all things necessary to handle the coal. He did not consider all these things when he talked to Mr. Purington. He saw Mr. Purington's grand results, and his low figures for burning brick with oil, and took it for granted he could do it too.

MR. PURINGTON—He did not get it from me.

MR. EUDALY—Well, he told me so, and he is a nice gentleman and so is Mr. Purington a nice gentleman. [Laughter.] I think it is proper and right to put gentlemen on their guard in reference to these matters. I know gentlemen who have gone to other cities using oil, and have gotten into the same trouble, and have had to pay for the experiment. Some gentlemen in Chicago have done the same thing—even there some of them can not make a success burning brick with oil. And so it is with these gas producing kilns, and so it is with all these departments in this business. It is quite well for you gentlemen to talk about this and that and the other thing, and about how nice it works, and about its cheapness and its wonderful results; but, gentlemen, you must know something about the circumstances under which such successes have been achieved, and the strong statement which Mr. Purington made, that if he had to go back to burning brick with coal or wood again he would quit the business, seemed to strike this convention rather forcibly, and some might feel, perhaps, that Mr. Purington was at a great advantage using oil, and they not being able to use oil or gas in some form could not possibly succeed in the brick business. That is just about the way I feel about it, and so I thought I would take the liberty of giving you an idea of how some people have fallen into an error by imitating some people who are making a success, and not getting all of the circumstances which form the basis of such success, and not getting that other requisite that makes all business a success, and that is "git up and git." [Applause.]

BRIDGES.

Cedar County, Mo., contemplates building nine bridges at a cost of $30,000.

$30,000 will be expended in the improvement of the Hannibal, Mo., bridge.

At Philadelphia, Pa., $75,000 will be expended in the erection of two new bridges.

The viaduct to be built across Belknap street, Superior, Wis., will cost about $50,000.

The Berlin Bridge Company has been awarded the contract for five iron bridges to be erected at Lockhart, Texas.

A bill has been introduced in the state senate appropriating $20,000 to build a bride at Rowe street, Rochester, N. Y.

It is proposed to extend Main street, South Bethlehem, Pa. To do this it will be necessary to build a bridge to cost about $30,000.

James Kincaid has the contract for the substructure of the west approach to the Taylor street viaduct, Chicago, Ill., to cost $18,000 to $20,000.

Seventy thousand dollars in bonds will be voted at Ventura, Cal., of which $50,000 will be used in the construction of a bridge across the Santa Clara.

Plans for the Eighth street viaduct in Cincinnati have been approved, and a resolution passed that proposals will be asked for in about three months.

It has been decided to build a bridge over the Wisconsin river at Wausau, Wis., at a cost of $6,000, said structure to have two spans of 100 feet in length.

The Waterbury and Meriden Railway bridge over Little river near Danbury, Conn., has been wrecked and a new iron bridge will be constructed.

The Pennsylvania Railroad Company intend to build four new bridges, on the line of the traction road between Frankfort and Tacony, Pa., at a cost of $200,000.

The bridge and four hundred feet of the long trestle of the Housatonic Railroad Company at Shelton, Conn., has been washed away by the recent storms.

The commissioners of Mesa county, Colo., have let the contract for the new bridge across the Gunnison to the Kansas City Bridge and Iron Co., of Kansas City, Neb.

A new high wagon bridge will be constructed over the Mississippi river at Winona, Minn.; it will be 35 feet above the high water mark, and 70 feet over the low water mark.

The proposed new Arlington suspension bridge over the Potomac will have a clear height of 105 feet above the water, the river to be 1,100 feet, and the two shore spans to be 625 feet each.

The Wisconson and Minnesota Bridge Company has been organized with a capital of $75,000 to construct a bridge across the St. Louis river in Douglass county, Wisconsin, to the townsite of New Duluth, Minn.

The residents of the Eighth and Eleventh wards, Milwaukee, Wis., are agitating the question of building a viaduct across the Menominee Valley at Sixteenth street; $600,000 to $1,000,000 will probably be expended on same.

Improvement and Contracting News.

PAVING.

A busy paving season is expected in Detroit, Mich.

The citizens of Oskaloosa, Ia., will pave their streets.

The brick pavement question is agitated at Edwardsville, Ill.

Mack avenue, Detroit, Mich., is to be widened and paved.

Moss avenue, Peoria, Ill., will probably be paved with asphalt.

The repairs to the streets of San Francisco last year cost $114,726.50.

South Limestone street, Springfield, O., will probably be paved with brick.

$300,000 worth of granite paving will be done in Covington, Ky., before fall.

Maple avenue, Evanston, Ill., will be pave with asphalt at a cost of $22,478.

West Fourth street, from Vine to Elm, Des Moines, Ia., is to be paved with brick.

About 34,000 square yards of cedar block paving will be done in Minneapolis, Minn.

Wayne street, from Clinton to Hanna, Fort Wayne, Ind., will be paved with brick.

A campaign of street improvements will be opened in Grand Rapids in the spring.

Work has been begun in paving Chestnut street, Chattanooga, Tenn., with brick.

Extensive stone paving and curbing will be done in paving district No. 12, Lincoln, Neb.

Nineteen blocks of Moline avenue, Moline, Ill., will be paved with Purrington brick.

Paving district No. 3, Nebraska City, Neb., will be paved at an expense of $16,250.85.

Main street, from Bird to Church, Hannibal, Mo., will be paved with brick in the early spring.

South Ninth and South Eleventh streets, Tacoma, Wash., will probably be paved with fir blocks.

Ed. Callahan has been awarded the contract for grading Twelfth street, Omaha, Neb., at $1,117.54.

Fifteenth, Twelfth, and Ninth streets, between Pacific avenue and A street, Tacoma, Wash., are being paved.

There is talk of re-paving Woodward, Gratiot, Grand River and Michigan avenues, Detroit, Mich., during this year.

H. J. Stanley, city civil engineer of Cincinnati, says: "Cincinnati will do about $600,000 worth of granite and asphalt paving this year."

The North Side Improvement Association, of Indianapolis, Ind., are considering the question of paving Meridian street from Fall Creek south.

About ten thousand square yards of cedar block street pavement and about five thousand lineal feet of curbing, will be laid at Steven's Point, Wis.

Memphis, Tenn., is about to begin extensive street improvement. It is proposed to issue $2,000,000 of five per cent. bonds to pay the cost of it.

Parts of River, Chicago, Division, Milwaukee and DuPage streets, and Douglas and Grove avenues, Elgin, Ill., will be paved with either cedar blocks or bricks.

Messrs. H. & A. B. Aveline & Co., of Catania, have appointed Chas. W. Laache, of New York, sole agent for the United States for the sale of their Asphalt Mastic.

Locust street, from Harris avenue to Highland avenue, Norwood, Ohio; and Beekman street from Queen City avenue to Western avenue and Boone street from McMillan street to Manitou street, Cincinnati, Ohio, will be improved.

The Alliance, Ohio, Council has passed bond ordinances for the improvement of three streets, each over half a mile long; and the preliminary ordinance for a fourth street, 1,000 feet in length, which will require a bridge 228 feet long, drive-way 28 feet wide and two sidewalks, each six feet wide.

Brick pavements will be laid in Davenport, Iowa, on Main street, from Third to Fourth; Perry street, from Front to Fifth; Third street, from Western avenue to Warren street; Second street, from Scott to Warren; Ripley street, from Second to Fourth; Scott street, from Second to Fourth; Third street, from Rock Island to Front; Front street, from Third street to Tremont avenue, and on several alleys.

When the plumbers were putting in a water pipe on Royal street, near St. Francis street, they dug up a portion of the Nicholson pavement which was put down as a covering of the street twenty-two years ago. The blocks were found much worn on the surface side, but perfectly sound throughout, and even the plank foundation was as sound as when it was put down. The blocks and planking are of pine wood.—*Mobile, Ala., Register.*

Atkinson & Oloff, of Rock Island, Ill., have been awarded a contract for paving in Davenport, Iowa, to cost $101,208.71. The streets covered by the contract let are as follows: Perry street, from Fourth to Fifth; Scott street, from Second to Fourth; Ripley, same; Main, from Third to Fourth; Second, from Scott to Warren; Third, from Western avenue, to Warren and Rock Island to Front; Front, from Third to Tremont avenue, and two blocks of alley. Added to these fresh contracts are six blocks on Fourth street and two on Main which were let last year and which will be done this year as soon as the work can be reached. This will make a total of thirty-one blocks outstanding to be done this year.

WATER-WORKS.

York, Pa., proposes to own its water-works.

Kanepa, Pa., is without adequate water-works.

Water pipes will be extended in Norwalk, O.

$15,000 will be spent at Antwerp, O., for water-works.

The water-works of Batavia, N. Y., will be improved.

Millertown, N. Y., will issue bonds for a water supply.

Water-works are being talked of in Townsend, Vt.

Orange, Mass., wishes to establish a water-works system.

Work has commenced on the artesian wells at Paris, Tex.

The water-works question is being agitated in Canton, Ill.

Norwalk, O., will expend $25,000 in extending water mains.

New water mains will be laid in many of the streets of Lynn, Mass.

Water pipe extension is being thoroughly discussed in Norwalk, Ohio.

The citizens of Ft. Valley, Ga., have voted in favor of a water-works system.

The citizens of Ipswich, Mass., have voted to establish a system of water-works.

Iron water mains and pipes will be laid in sundry streets of Salt Lake City, Utah.

The Albert Lea, Minn., council solicits specifications for a system of water-works.

The question of establishing a water-works system in Aurora, Mo., is being agitated.

The Lawrence, Mass., water-works system will be improved to the extent of $40,000.

A new water-works company will begin operations within a short time at Columbus, Ga.

$200,000 will be expended in Cincinnati, O., during next summer in extending water-works.

The water committee of Camden, N. J., will investigate means for improving their water supply.

Wheeling, W. Va., wants plans and estimates for the construction of a water-works system.

Pipe laying for the $125,000 water-works system to be put in at Milledgeville, Ga., will commence soon.

Denver capitalists are interested in the water-works at La Grande, Ore., which will cost about $60,000.

An ordinance was introduced in the Charleston, S. C., council to issue $75,000 of bonds for new water-works.

The Belleville water-works proprietors are seeking a location for a plant on the Mississippi river near Venice, Ill.

At Boulder, Colo., almost 3,000 feet of additional water mains are to be laid up Twelfth street, to University place.

H. H. Bourne of Trinidad, Colo., has secured the contract for putting in a new system of water-works at Quanah, Tex.

An ordinance for placing water mains on Penn street, from Fifteenth to Sixteenth streets, has been passed in St. Joseph, Mo.

A bill will be introduced in the legislature authorizing Schenectady, N. Y., to issue $125,000 worth of bonds for a water supply.

The question of extending water-pipes on streets not now supplied, is being agitated in Cleveland, Ohio. The cost will possibly be from $30,000 to $40,000, and an election will be held in the spring to vote on the same.

The Quincy, Ill., council has passed an ordinance providing for the construction of water-works at that place.

Water mains are soon to be laid, at Hinsdale, Ill., which will require 3,750 feet of eight inch pipe, and 3,300 feet of six inch pipe.

The water-works trustees of Ravenna, O., contemplate making about 3,000 feet of extensions on Mill and Diamond streets the coming season.

The Los Angeles, Cal., water-works company anticipate putting in an eight-inch water pipe on Griffin avenue, to extend into Boyle Heights.

The Martense Water Company has been incorporated with a capital stock of $10,000, to furnish water for the towns of Flatbush and New Utrecht, N. Y.

Water-works will be established at Astoria, Ill., Woodstown, Pa., Luverne, Minn., Standish, Mich., Elkton, Md., Uvalde, Tex., LaGrande, Ore., and Dayton, Wash.

The St Martinsville, Tenn., council has contracted with J. M. Ware to sink an artesian well in the court-house square to cost from two to three thousand dollars.

The Butler, Mo., city council has decided to put in water-works to cost $35,000, and Messrs. Ingels & Moody, of Nevada, Mo., will possibly receive the contract.

The franchise for water-works, at Butler, Mo., has been granted to Walton, Tygard, Clark & Jenkins, of that city, who will put in a plant the same to be completed by September 1.

A new water supply, estimated to cost $125,000, has been recommended in Schenectady, N. Y. Wells may be sunk on Van Slyck Island, in the Mohawk River, above the city.

Work on the reservoir on the Knobs now being constructed by the Water Works Company of New Albany, Ind., is progressing rapidly; over 3,000,000 bricks will be required for its walls, and when complete will have a capacity of nearly 3,000,000 gallons of water.

Water-works are agitated at Chester, Macomb and Beardstown, Ill., Lowville, N. Y., Macon, Ga , Chillicothe, Ill., Walden, N. Y., Kansas City, Kan., Peru, Neb., Fullerton, Neb., Alameda, Cal., Fort Clinton, Ohio, Warrensburg, Mo., Coville, Wash., Hickory, N. C. and Fairmont, W. Va.

SEWERS.

Salem, O., is to have a sewerage system.

New sewers will be built at Harrisburg, Pa.

Cicero, Ill., is to have a system of sewers to cost $418,445.75.

Newport, R. I., proposes to issue bonds for sewer construction.

Sewer work will be commenced in the spring at Huntington, W. Va.

Newport, Ky., will spend about $500,000 on streets and sewers this season.

The Pawtucket, R. I., council has ordered a sewer in Gooding street to cost $5,400.

Sewer work has been commenced by Contractor McCoppin in Little Rock, Ark.

The contract for sewering William street Oakland, Cal., has been let to J. K. Carpenter.

Sewers will be constructed at Iowa City, Iowa, to be 9,000 feet long, and cost about $9,000.

Col. Waring is preparing plans for the disposal of the sewage of the Bryn Mawr (Pa.) Hotel.

Bonds will be issued in Mt. Vernon, N. Y. for sewer improvements to the amount of $150,000.

John E. Bretz has been awarded the contract for building the Hickox avenue sewer, Springfield, Ill.

Ordinance has been passed at Oak Park, Ill., for Oak Park and Ridgeland avenue sewers, to cost $375,000.

A sewer to cost $150,000 is to be constructed by Erie, Pa., to carry sewerage outside the breakwater.

The council of Baltimore, Md., has provided for the construction of numerous sewers and water mains.

A sewer will be built in Nepparhan avenue from Yonkers avenue to Garden street, Yonkers, N. Y.

A new sewer will be constructed in Hawley street Black Rock, N. Y. Twelve and ten inch pipe will be used.

Daley & McGavock have been awarded the contract for sewer work in district No. 125, Omaha, Nebr., at $4,106.45.

Gilbert Avenue in Cincinnati, O., will be sewered from Westminster avenue to the trunk sewer east of Beresford avenue.

The question is being agitated in Detroit, Mich., of a trunk sewer, extending along the river bank the entire length of the city.

Jones & Breen have received the contract at $628 for building a brick sewer on the site of the New Model Mill in Nashville, Tenn.

Mr. Henry Rawie, the city engineer of Anderson, Ind., has been authorized to consult Col. Waring, concerning plans for the sewerage of the city.

It is proposed to build a sewer at Rochester, N. Y., to drain the outline portions of the Ninth and Fifteenth wards, and parts of the towns of Chilin and Gates.

1,500 feet of eight-foot; 2,000 feet of seven-foot; 3,600 feet of six-foot; 4,400 feet of five-foot; 5,200 feet of four-foot brick sewer will be constructed at Patterson, N. J

A bill will be presented by the legislature providing for the appropriation of $100,000 for the construction of an intercepting sewer in Wilmington, Del.

A bill will be introduced into legislature to authorize the additional issue of bonds for $300,000 to pay for the sewer system in the Twenty-sixth ward, New York City.

The city authorities of Birmingham, Ala., are discussing the adoption of strict plumbing regulations, and Col. Geo. E. Waring, Jr., of Newport, has been instructed to submit a code of rules, with recommendations.

The Minneapolis, Minn., board of public works has awarded the contract for the reconstruction of the portion of the Seventh street sewer lying between Minnesota and Robert streets to Wm. J. Preston at $1,064.

E. F. Layman, civil engineer Cincinnati, O., has just finished plans and profiles for a system of grades and drainage for the village of Arlington Heights, and is also preparing estimates for a sewerage system for Winton Place, O.

An ordinance has been introduced at Atlanta, Ga., providing for the erection of a sewer from Crew street southwardly to near the old city line near Martin street to cost $40,000. Also to construct a sewer from Baker street northwardly to the old city line near Third street at an estimated cost of $50,000.

Sewers will be built between Dorr street and Detroit avenue, Toledo, O.; in E. Twenty-first avenue, from Eighth avenue westerly, Oakland, Cal.; in Clement avenue, from Seventeenth to Twenty-second avenue, Alameda, Cal.; in W. Main street from Public Square to Richland Creek, Belleville, Ill.; in Seventh street, Indianapolis, Ind.; in Fifth street from Iowa to White, Dubuque, Ia.; through blocks 44 and 41, Kankakee, Ill.; in River street, Manchester avenue, E. Twenty-fifth street, Welcome street, Matlock street and Graham avenue, Patterson, N. J.; in Broomall street, Chester, Pa.; in Thirty-fourth street, Brooklyn, N. Y.; various streets of Roanoke, Va.; and in Daniels street, Toledo, O.

STREET LIGHTING.

The light question is being agitated at Newark, O.

There is a demand for cheaper light at Mansfield, O.

There is great dissatisfaction with the electric lights of Warren, O.

Middletown, Conn. is agitating the question of owning its electric plant.

Wheeling, W. Va., will either erect an electrical plant or contract for electric lights.

The Edison General Electric Company have increased their stock from $12,000,000 to $15,000,000.

The Supreme Court decides that towns in the state of Massachusetts have no right to maintain electric light plants.

Extensions will be made to electric light systems in Superior, Wis., Appleton, Wis., Baltimore, Md., and Bethlehem, Pa.

The new Electric Light Company of New Albany, Ind., will erect a gas plant, and furnish gas for both fuel and lighting purposes.

There is a movement on foot between the authorities of Georgetown, and Silver Plume, Colo., to put in an electric light plant with power enough to light both towns.

The Electric Light Company of Waukegan, Ill., is enlarging its plant so as to run arc dynamos to light the city with 65 arc lights of 2,000 candle power, which will be put up.

The electric light subject is being discussed at Rochelle, Ill., Waterloo, Ill., Walden, N. Y., Vergennes, Vt., Milton, Pa., Athens, Ga., Ashtabula, O., Madison, Kan., Denver, Mich., Waynesboro, Pa., Lexington, Va., Rogers Park, Ill., Leslie, Mich., and Reading, Pa.

Electric light plants will be erected at Homestead, Pa., Green Bay, Wis., Leslie, Mich., Salem, Ind., Indiana, Pa., Wheeling, W. Va., Macon, Ga., Aurora, Colo., Lake Charles, La., Colorado, Tex., Elberton, Ga., Farmville, Fla., Pulaski, Va., Roseburg, Oregon, Ashland, Ill., and Janesville, Wis.

STREET RAILWAYS.

An electric street car line is being talked at New Albany, Ind.

The electric line of Ridgeland, Ill., will be in operation March 1st.

There is demand for an electric railway from Baden, Mo., to St. Louis.

The Essex Electric Street Railroad, of Salem, Mass., will extend their tracks.

Within the next six months electric cars will be running at Cedar Rapids, Iowa.

The Pittsburgh, Pa., suburban Rapid Transit Company will extend their tracks.

It is proposed to extend the tracks of the West Chester, Pa., Electric Street Railway.

The Bridgeton, N. J., street railway project is an assured success. An ordinance has passed council.

The Minneapolis, Minn., Street Railway Company intends building an electric line to Lake Minnetonka.

An electric street railway will be constructed at Macon, Ga., by the Ocmulgee Land and Canal Company.

Parties from Du Quoin contemplate building an electric street railway to connect Jonesboro with Anna, Ill.

Centralia, Ill., will have electric street cars, council having granted a twenty-year franchise for that purpose.

The citizens of Claverack, N. Y., are anxious to have the Hudson Electric Railway extend their tracks to that place.

The Lehigh Avenue Railway, Philadelphia, Pa. will hereafter be operated by horses instead of the storage battery.

The White Electric Traction Company will build a double track electric street car line from McKeesport, Pa., to Duquesne.

The Rivermont has contracted with the Edison Company for double track electric street railway to cost $65,000,in Lynchburg.

The River Forest, Ill., electric road is to be extended from Harlem ave. on Madison street to the river. Double track will be laid.

The selectmen of Camden, Me., have refused the request of the Camden and Rockport Electric Railroad Company to locate their tracks through the streets of Camden.

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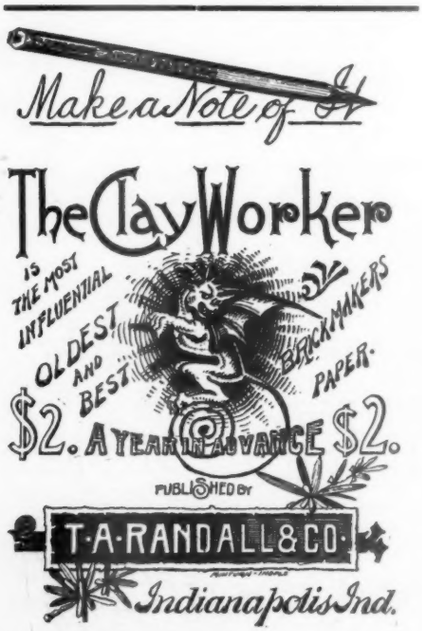
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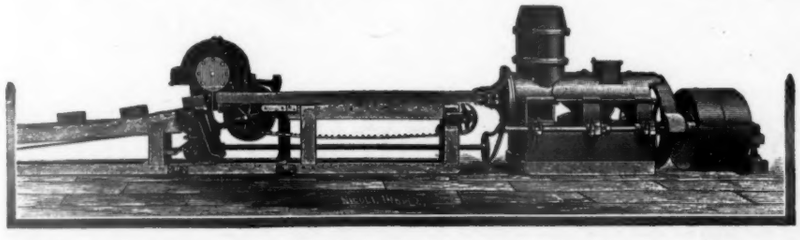

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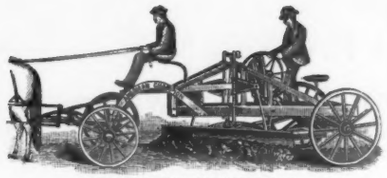

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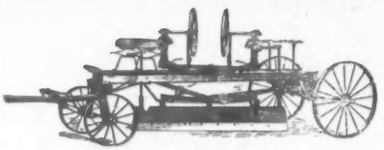

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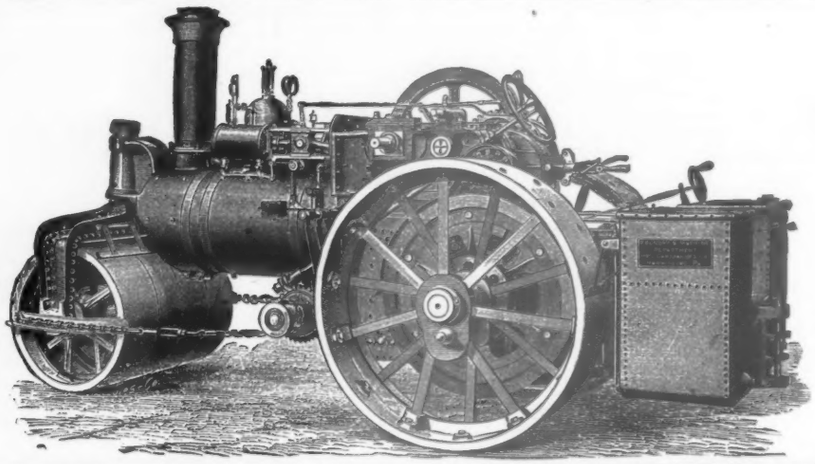

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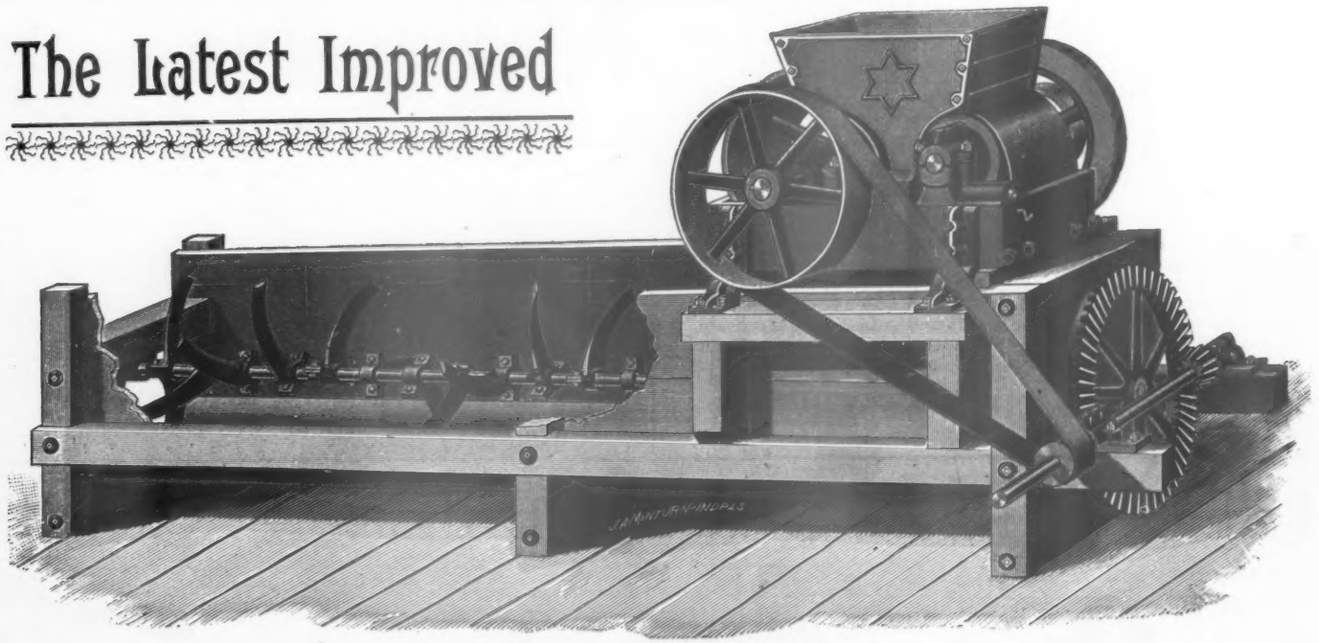

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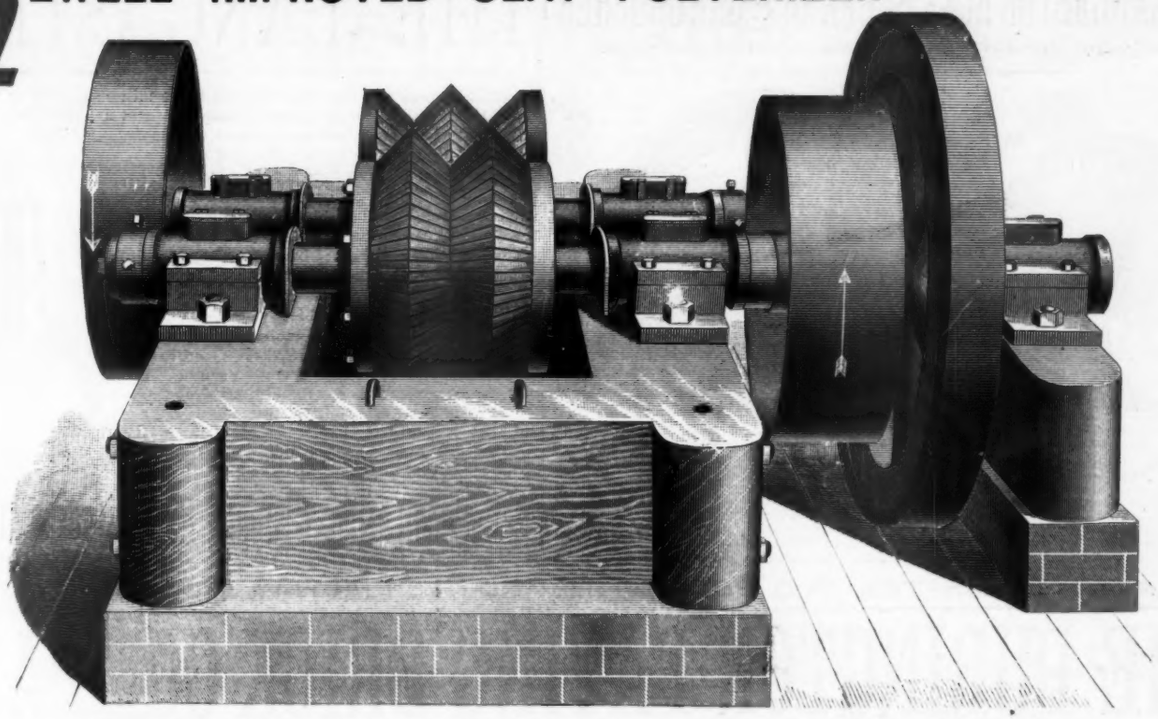

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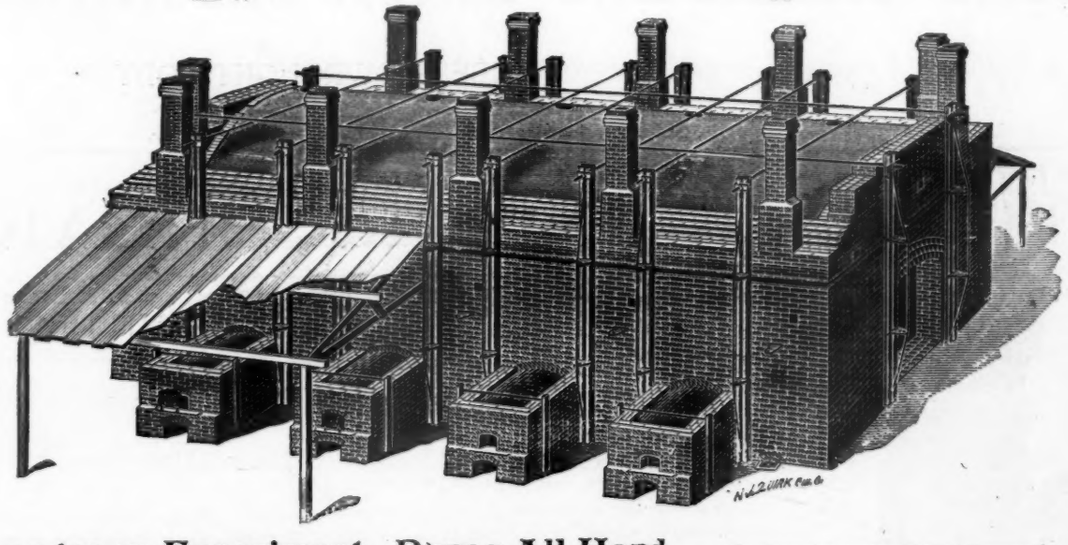

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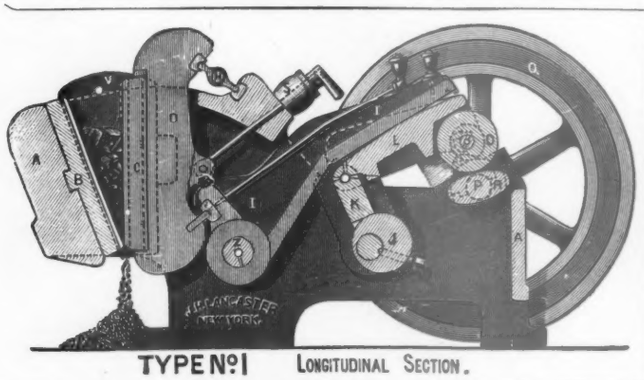

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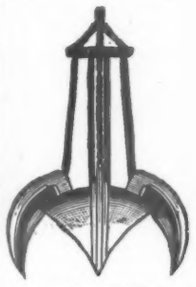

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Is now building one of the most extensive and best equipped plants ever established for the manufacture of Paving Brick.
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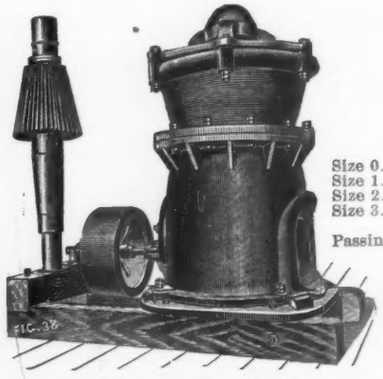

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Size 2	6 to 12 tons per hour.	Size 6	30 to 60 tons per hour.
Size 3	10 to 20 tons per hour.	Size 7	40 to 75 tons per hour.
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Great Saving in Power. Adjustable to any Degree of Fineness. The principle involved in this Breaker acknowledged to be the greatest success ever introduced into Stonebreaking machinery. The Gates Breaker has made more railroad ballast and road metal than all other kinds of breakers combined. **Universally Adopted by Mining Companies. Many Hundreds Used by Railway Companies.** Will furnish a thousand references from Contractors, Street Superintendents, Mines, Cement Manufacturers, etc. Also Manufacture

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The Largest and Finest Collection of Specimens of Paving

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Paving Exposition Committee

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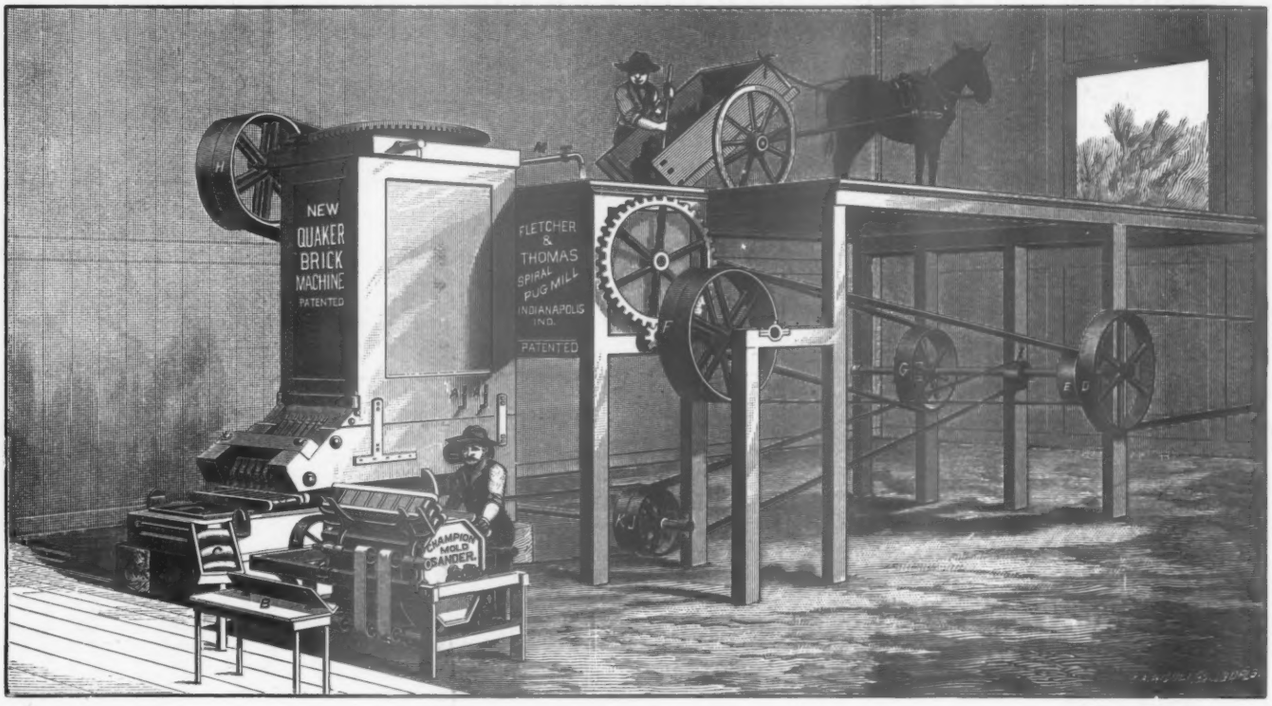

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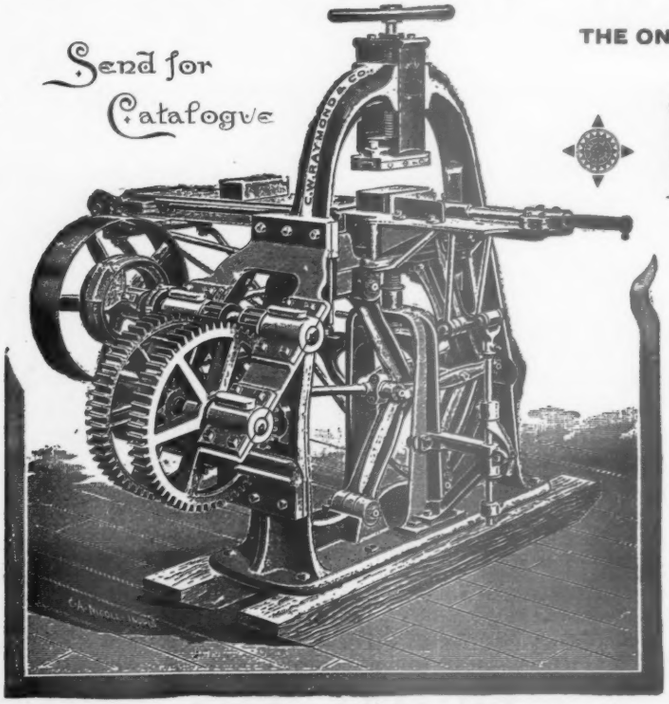

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